# EXHIBIT 1:

# Third Amended Complaint and Exhibits A, B, C and D

# REDACTED VERIONS OF DOCUMENT(S) SOUGHT TO BE SEALED

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*Attorneys for Plaintiff,*
*Space Data Corporation*

**IN THE UNITED STATES DISTRICT COURT**
**FOR THE NORTHERN DISTRICT OF CALIFORNIA**
**SAN JOSE DIVISION**

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|---|---|
| SPACE DATA CORPORATION,<br><br>Plaintiff,<br><br>v.<br><br>X, ALPHABET INC., and GOOGLE INC.,<br><br>Defendants. | Case No.: 5:16-cv-03260-BLF<br><br>**THIRD AMENDED COMPLAINT FOR:**<br><br>1. PATENT INFRINGEMENT UNDER 35 U.S.C. § 1 *et seq.* ('941 Patent);<br>2. MISAPPROPRIATION OF TRADE SECRETS UNDER 18 U.S.C. § 1836 & 1837;<br>3. MISAPPROPRIATION OF TRADE SECRETS UNDER CALIFORNIA CIVIL CODE § 3426, *et seq.*;<br>4. BREACH OF WRITTEN CONTRACT;<br>5. PATENT INFRINGEMENT UNDER 35 U.S.C. § 1 *et seq.* ('503 Patent); and<br>6. PATENT INFRINGEMENT UNDER 35 U.S.C. § 1 *et seq.* ('706 Patent)<br><br>**JURY TRIAL DEMANDED** |

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Plaintiff, SPACE DATA CORPORATION ("Space Data"), by way of its Third Amended Complaint against Defendants, alleges as follows:

## I. INTRODUCTION AND SUMMARY.

1. The internet has changed how we live. In urban areas, we are online all the time: constantly checking where to eat, meet, buy gas, the new political news, the President's latest tweet, and so on. Life without internet access would be unworkable, unthinkable. The web has become the water we swim in, as ubiquitous and critical as oxygen. *Cf.* David Foster Wallace "This is Water" Address (*see* https://web.ics.purdue.edu/~drkelly/DFWKenyonAddress2005.pdf).

2. All are not so fortunate, however. People who live in remote or undeveloped areas rarely have online access. Terrestrial infrastructure is **expensive**, especially when spread across a thin population base. A cell tower costs what it costs, regardless of whether it serves a hundred people in Wyoming or a hundred thousand people in Manhattan.

3. As we write, two out of every three human beings lack internet access. There are great swaths of this and other countries with no wireless access. This creates a very real digital divide.

4. As an important aspect of its ongoing business strategy, Google has made universal internet access a corporate priority. Google's goal is not entirely altruistic, as Google's value as a business depends in large part on Google's ubiquity. But bringing all the information to all of the people is impossible if most lack internet access.

5. And so we come to balloons. In 1997 and 1998, Space Data was developed by two MIT engineers to build a constellation of floating balloons, each linked to the other, communicating from the stratosphere to earth-based mobile devices. Instead of a laborious and expensive terrestrial buildout, Space Data envisioned an array of inexpensive floating balloons, quickly and cheaply creating a stratospheric communications platform, thereby bringing internet to all. These balloons would essentially "sail" in the stratosphere, riding micro-wind currents meticulously mapped through hundreds of thousands of hours of test and data collection flights. Contrary to all conventional wisdom, there exists a "peaceful band" in the stratosphere, that is, a region where the winds are calm, relatively predictable, and sufficiently **structured** to enable an

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operator to fly an unpowered balloon by adjusting its altitude to catch different, segregated wind currents. These wind patterns make it possible to choreograph a balloon array to keep the balloons in tight concert, and so enable the balloons to work as a coherent uniquitous network.

6. Over years of development, and $75 million of private investment, Space Data perfected its technology. It filed for its first patent in 1999, and now owns many foundational patents, including one captured from Google in an interference proceeding, as set forth below. Space Data's technology has been purchased by the U.S. military and deployed in Iraq and other war theaters. Space Data also has numerous private sector commercial customers, *e.g.* oil service companies needing network coverage in remote areas to monitor oil wells and pipelines. *See* below, ¶ 57.

7. Beginning in the fall of 2007, Google began a detailed technical due diligence of the Space Data business, finances, and technology. Under NDA, Space Data disclosed proprietary information to Google, all to aid Google in its technical evaluation and pre-acquisition Space Data due diligence. Google cofounders Larry Page and Sergey Brin were involved in the Space Data due diligence in a very hands-on way (literally; *see* below).

8. The Google due diligence culminated with the Google team, including the two Google cofounders visiting Space Data's Chandler, Arizona facility on February 15, 2008. When Google arrived, Space Data was flying a commercial constellation of balloons over Louisiana and West Texas, providing internet access to remote oil rigs. As the constellation flew, computer monitors in the Space Date Network Operations Control Center ("NOC") reflected the status of each balloon, including proprietary wind data, "hover" algorithms, and similar sensitive information, as set forth below. *See* below, ¶¶ 104-129. These pictures were themselves captured in pictures taken by the Space Data employees, as a visit from the two Google co-founders is far from an everyday occurrence.

9. Despite its earlier professed eagerness to acquire Space Data, Google abruptly went dark weeks after this meeting.

10. And that brings us to Space Data II, now known as Project Loon.

11. Google publicly launched Project Loon in mid-2013. Project Loon consists of an array of balloons floating in the stratosphere, each communicating with the other, and communicating with the ground to create a stratospheric internet platform. Google does this exactly as did Space Data, down to the smallest technical details, *e.g.*, micro-mapping stratospheric winds in order to sail the balloons to maintain the integrity of the constellation over time and space.

12. In interviews after it launched Loon, several Google engineers explained that Google's great Loon epiphany was that one can choreograph a balloon array in the stratosphere once one understands the micro-wind patterns in the quiet, peaceful band. This, said Google, made it possible to "sail" the balloons and so control the array, all to make the airborne constellation work as a wireless communications mesh. Indeed, Google filed a patent claiming this micro-wind mapping constellation sailing as a Google invention in January 2012, along with a request not to publish the application, as set forth below. This initial filing was soon followed by many dozens more, all claiming as original Google inventions ideas patented by Space Data and disclosed by Space Data to Google under a non-disclosure agreement years before.

13. The Project Loon balloons have means of ascent and descent, as do the Space Data balloons; they have wireless transceivers attached, as do the Space Data balloons; they have GPS capabilities; as do the Space Data balloons; they have twin redundant termination mechanisms; as do the Space Data balloons; they fly the stratospheric micro-currents, as do the Space Data balloons, they have cut-down mechanisms, as do the Space Data balloons, and so it goes, detail by technical detail.

14. On information and belief, Google is spending over $1 million a day on the Google Loon Project. It has successfully deployed balloons over the world, including in California and elsewhere in the United States.

15. Google, itself, announced that Google Loon would make substantial profits. As of March 2015, Google controlled 88 percent of the search world worldwide. Google estimated that if 250 million people (approximately 5 percent of the total people worldwide without internet access) paid $5 per month for the service, Google could bring in tens of billions of dollars per year. As Google's Mike Cassidy said: "Think about it, with 4.5 billion people without internet access,

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take 5 percent; you're talking 250 million people. If those people pay just a small portion of their monthly income, say $5 a piece, you're going to be in a billion dollars a month in revenue, tens of billions a year in revenue, so it's a good business, too." This, said Google, was the future of Loon.

16. As set forth in detail below, Project Loon improperly uses Space Data's confidential information and trade secrets which Space Data disclosed under a 2007 Mutual Confidentiality and Non-Disclosure Agreement ("NDA"), attached hereto as Exhibit A and incorporated herein by reference. Google's use of this confidential information is also a breach of that same NDA. Project Loon also infringes Space Data's patents, including claims that Google itself filed in January 2012, but Space Data clawed back in an administrative interference proceeding in late 2016 and early 2017.

17. Accordingly, Space Data files this Third Amended Complaint for: (1) infringement of United States Patent No. 6,628,941 titled "Airborne constellation of communications platforms and method" by Knoblach et al., ("the '941 Patent") arising out of the patent laws of the United States, 35 U.S.C. § 1 *et seq.*; (2) misappropriation of trade secrets under the Defend Trade Secrets Act ("DTSA"), 18 U.S.C. § 1836; (3) misappropriation of trade secrets under California Uniform Trade Secrets Act, Civil Code § 3426, *et seq.*; (4) breach of written contract under California law; (5) infringement of US. Patent No. 9,632,503 ("Systems and Applications of Lighter-Than-Air (LTA) Platforms") ("the '503 Patent") arising out of the patent laws of the United States, 35 U.S.C. § 1 *et seq.*; and (6) infringement of US. Patent No. 9,643,706 ("Systems and Applications of Lighter-Than-Air (LTA) Platforms") ("the '706 Patent") arising out of the patent laws of the United States, 35 U.S.C. § 1 *et seq.* Counts I through VI are against Defendants Alphabet and Google Inc. ("Google"). Alphabet and Google are referred to collectively as "Defendants" hereinafter.

## THE PARTIES

18. Space Data is an Arizona corporation, with its principal place of business at 2535 W. Fairview Street, Suite 101, Chandler, Arizona 85224-4707.

19. Space Data was co-founded by Jerry Knoblach and Eric Frische. Mr. Knoblach began concept development, research, planning, and organizational work for Space Data in

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December 1996. Mr. Knoblach earned a Master's of Business Administration (MBA) Degree from Harvard University in 1992, a Master's Degree in electrical engineering from the University of Minnesota in 1990, and a Bachelor's Degree in mechanical engineering from the Massachusetts Institute of Technology (MIT) in 1985. Mr. Knoblach has been awarded two patents outside of the business of Space Data.

20. From 1996 to 1998, Mr. Knoblach was a program manager at CrossLink, Inc., a wireless communications equipment company. At CrossLink, he led an effort to develop a commercial communications system for the space shuttle, using a satellite system that provides connections to the Internet, voice and fax capabilities and the use of commercial hardware to enable rapid development. The system first flew in June 1998. From 1992 to 1997, Mr. Knoblach was a manager of business development and a program manager for Orbital Sciences Corporation ("Orbital"). From 1995 to 1997, he was responsible for marketing radiosondes (a device attached to a balloon that tracks weather and wind data as the balloon ascends) and satellite ground stations. In 1996, he played a key role in winning a contract with the U.S. Air Force to develop and produce the next generation radiosondes using GPS technology (given the expense, the GPS enabled radiosondes were slow to deploy). From 1994 to 1995, Mr. Knoblach served as a program manager at Orbital's subsidiary, Magellan Systems Corporation ("Magellan"), where he led the effort to develop the first handheld, personal communicator for use with the Orbcomm satellite network. Mr. Knoblach managed a marketing effort that won a contract to develop a GPS guided missile during 1992 and 1994. Prior to Orbital, Mr. Knoblach spent five years at FMC Corporation in Minneapolis, Minnesota, designing missile launchers for the U.S. Navy and Air Force.

21. Eric Frische co-founded Space Data and served as its Chief Technical Officer and as a Director. Mr. Frische earned a Bachelor's Degree in electrical engineering from MIT in 1985. He is a licensed patent agent and has been awarded multiple patents outside of the company. From 1989 to 1998, Mr. Frische owned and operated Applied Solutions, which was a prototyping company in Dallas, Texas. Mr. Frische was responsible for all aspects of business at Applied Solutions, from marketing to engineering and production. During his tenure, Mr. Frische developed a wide variety of prototypes in areas ranging from communications devices to toys to

aides for the handicapped. Prior to Applied Solutions, Mr. Frische was a captain in the U.S. Air Force. Mr. Frische worked at the National Security Agency ("NSA") where he developed a microwave lab and research program that investigated reception of faint RF signals. Both Mr. Knoblach and Mr. Frische have served on the American Institute of Aeronautics and Astronautics (AIAA) Scientific Balloon Systems and Technology Committee.

22. Alphabet is a Delaware corporation, with its principal place of business at 1600 Amphitheatre Parkway, Mountain View, California 94043-1351. Alphabet is the successor issuer to, and parent holding company of, Google. Alphabet owns all of the equity interests in Google. The reorganization of Google into Alphabet was completed on October 2, 2015.

23. Google is a Delaware corporation, with its principal place of business at 1600 Amphitheatre Parkway, Mountain View, California 94043-1351.

**JURISDICTION AND VENUE**

24. Space Data brings its action for patent infringement under the patent laws of the United States, 35 U.S.C. § 271 *et seq.* This Court has federal question subject matter jurisdiction over Space Data's patent infringement claims under 28 U.S.C. §§ 1331 and 1338(a).

25. This Court also has federal question subject matter jurisdiction under the DTSA, 18 U.S.C. § 1836. This Court has original jurisdiction over this controversy for misappropriation of trade secrets claims pursuant to 18 U.S.C. § 1836(c) and 35 U.S.C. § 1331. This Court has supplemental jurisdiction over the controversy for all other claims asserted herein pursuant to 28 U.S.C. § 1367.

26. Venue is proper in this District under 28 U.S.C. §§ 1391(c)-(d) and 1400(b) because (i) Defendants maintain their principal places of business in this District, and (ii) this is a District in which Defendants are subject to the Court's personal jurisdiction with respect to this action, and/or the District in this State where Defendants have the most significant contacts.

**INTRADISTRICT ASSIGNMENT**

27. Pursuant to Civil Local Rule 3-2(c), this intellectual property action would be properly assigned to any division within this district. The parties, however, agreed to adjudicate any dispute arising out of the NDA, which forms a basis for the trade secret allegations, in the state

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or federal court of Santa Clara County, California. *See* Exhibit A, hereto, § 17. Assignment to the San Jose Division would therefore be proper.

## II. STATEMENT OF THE FACTS.

### A. Airborne Communications Platforms.

28. Until recently, there were two basic ways to provision a large-scale wireless network: a terrestrial tower-based infrastructure, or a satellite array orbiting the earth.

29. Terrestrial networks are expensive to build and are economic only when the cost can be spread over many people. It is economic to build a cell tower in Manhattan; it is not in rural Wyoming. As a pragmatic matter, a terrestrial tower system will never bring the internet to all.

30. Satellites, too, are very expensive. A satellite can cost well in excess of $10 million to build, and an additional $100 plus million to launch. According to the Union of Concerned Scientists, there are 600 non-military, communications satellites operating today versus the over five million cell sites which service the third of the world's population with a wireless broadband device. Even if the number of communication satellites increased ten-fold, those satellites would need nearly a thousand times the capacity of a typical cell phone tower to have enough capacity to serve the uncovered population. More, since satellites orbit at great distance from the earth, latency (delay), poor signal strength, and limited spectrum limit an average satellite to lower capacity than the average cell phone tower. Again, as a pragmatic matter, a satellite network will never bring the internet to all.

31. Satellites in geostationary orbit, *i.e.* placed in orbit to stay in a fixed spot relative to a terrestrial location, are placed at roughly 23,200 miles above the earth. Given this great distance, custom equipment is needed to receive and use signals form the distant satellites, *e.g.*, special receiving dishes. This equipment is expensive, and this expense presents a further barrier to broad-based satellite provisioned internet.

32. Satellites in low earth orbit (*e.g.*, Iridium communications satellites at a height of approximately 485 miles) are not geosynchronous, and they move across the sky (at about 17,000 miles per hour) relative to a fixed terrestrial location. To receive signals from these satellites, each

receiver needs to track the satellite to receive the signal. This requires additional ground-based infrastructure. And this is expensive. For example, Motorola founded Iridium to create a new low earth orbit satellite network. The system cost billions to build, but the required "sat" phone cost and cost of phone time proved prohibitive and the network failed. Iridium emerged out of bankruptcy and is a niche player today, serving limited industrial, government, and aviation markets.

33. Given these inadequacies, and the ever-increasing need for additional bandwidth and greater geographic coverage, there is a need for a better approach, a third way to create an airborne communications network.

**B. Balloons and Airships.**

34. Communication engineers have considered using the airborne equivalent of cell towers for years. Historically, there have been two basic approaches: (1) motorized lighter than air craft (Goodyear blimp), or unmanned, unmotorized balloons (*e.g.*, weather balloons).

35. Airships (dirigibles) did not and do not work. To keep a dirigible in place in the troposphere or stratosphere requires significant amounts of energy, as the dirigible will battle the wind ceaselessly. It is simply not possible to station a dirigible in a fixed location for any length of time; the energy requirements are prohibitive. For example, Lockheed-Martin launched (with great fanfare) a giant airship to create an airborne cell tower in 2011, the High Altitude Airship – (HALE-D). It was designed to fly at 60,000 feet, made it to 32,000 feet, malfunctioned, and had what Lockheed euphemistically called a sudden "controlled descent," *e.g.*, a slow motion crash.

36. The other approach involved tethered balloons. While attaching a very lengthy tether would fix the balloon in place, there were two other unsurmountable obstacles: the tether itself is very heavy, requiring ever larger balloons, until the system collapses of its own weight; and, (2) even assuming some solution to this tether-weight conundrum, hundreds if not thousands of balloons tethered to the earth would create obvious hazards to other aircraft.

**C. Space Data: a Sailing Constellation.**

37. Jerry Knoblach, as discussed above, had a background in communications and satellite technology. He appreciated the problems in using the satellite network to supply

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additional network bandwidth coverage for terrestrial users, just as he appreciated that powered dirigibles or tethered balloons would not work.

38. In late 1996, after significant research and development, Knoblach realized that it would be possible to develop a constellation of "near-space" balloons to create a floating network that could connect to terrestrial communications networks to provide coverage in areas cell towers do not reach. "Near space" is the area of the atmosphere above the range that jet airliners fly (30,000 to 52,000 feet) and far below the low altitude orbiting satellites (485 miles). This, thought Knoblach, was the new frontier for airborne communications networks. In 1997 and 1998, Knoblach and Frische developed this idea into the Space Data '941 Patent, attached hereto as Exhibit B and incorporated herein by reference.

39. This epiphany turned on a number of subparts, each important:

***The Balloon-Based Network***

40. By treaty, numerous countries release weather balloons twice a day. These weather balloons ascend rapidly, burst, and the payload parachutes to earth.

41. Given the rapid ascent, and the fact that these weather balloons were not equipped with sensitive GPS functionality until relatively recently, historical wind data in the stratosphere has been sparse and profoundly inaccurate. Weather balloons were not designed to provide micro-mapping of wind currents in the stratosphere, but rather provide metadata for basic weather modeling of the atmospheric layers where airliners fly and below. Until recently, these balloons were tracked with radio-theodolites, an instrument used to measure location and height. Such radio-theodolites provide very basic and error prone data on wind patterns, particularly at high altitudes (a function of how the radio-theodolites estimate wind, *i.e.*, by using azimuth as a critical measurement, and azimuth provides an increasingly distorted reading the higher the balloons ascend as a simple function of geometry).

42. Knoblach and Frische understood that it would then be possible to "sail" a constellation of balloons in a loose array by exploiting the wind patterns in the 60,000 to 140,000 foot altitudes and attach to those balloons a communications signal transceiver, so making feasible a balloon-borne communications network. Knoblach and Frische realized it would be possible to

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control a balloon's micro-**horizontal** location by adjusting its altitude, *i.e.*, moving the balloon up or down a modest amount to take advantage of the wind patterns to move the balloon to its desired horizontal location. The pair understood that it would then be possible to "sail" a constellation of balloons in a loose array by exploiting the wind patterns, so making feasible a balloon-borne communications network. If a balloon drifted out of place, one could raise it or lower it to catch a discrete wind stream to bring it back into position. Knoblach and Frische also realized that flying a network of balloons for communications would also generate high resolution stratospheric wind data of a quality beyond that publicly available, which would provide Space Data with valuable information.

43. Once test flights began in 2000, Space Data captured this high-resolution wind data and developed its proprietary knowledge of the micro-wind structure of the 60,000 to 140,000 foot range. The analysis of this proprietary data showed Space Data that there is a horizontal band in the stratosphere above 60,000 feet where the winds are particularly calm (15 to 20 mph), and, importantly, **structured**, *i.e.*, not blowing randomly (the "peaceful band") which sits (approximately) between 60,000 to 80,000 feet. This "peaceful band" analysis was derived from hundreds of thousands of hours of proprietary flight data. [redacted]

***<u>Use Moore's Law</u>***

44. Knoblach and Frische further realized that electronic circuitry was shrinking every year, and that it would be possible to build a radio transceiver that was less than 12 pounds, with two separate frangible components which would separate at impact, with each component weighing less than six pounds. This matters, as aircraft jet engines are built to withstand bird strikes of up to eight pounds. A balloon payload of less than 12 pounds that broke into two components of less than six pounds each (frangible) is, accordingly, exempt from regulatory hurdles as the payload would not pose a hazard to aircraft.

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45. Aviation regulations permit balloons with payloads greater than 12 pounds, but these heavier payloads cannot be launched on cloudy days. For example, in July 2013, under the sponsorship of the Federal Communications Commission and in conjunction with the National Institute of Standards and Technology, Space Data flew a 4G LTE (wireless protocol) payload that weighed 50 pounds to service public safety needs after Katrina-like disasters. Currently, Space Data is flying 4G LTE payloads that weigh less than six pounds.

***Cheap and Scalable***

46. Another key Knoblach-Frische realization was that such a choreographed stratosphere-based balloon constellation could provide needed network coverage at an extremely low cost, relative to the alternatives (millions of additional terrestrial towers, or many more satellites than could feasibly be orbited). Building a new tower-based network is **very** capital intensive, literally trillions of dollars to cover the uncovered areas of the world, and has to be built to provision the anticipated future traffic. Less than a third of the world's landmass had broadband wireless coverage as of 2013. Half the world's population lived within this coverage area, yet only about a third of the population used the Internet. These users were served by about five million cell phone towers. Since these existing towers cover only a third of the landmass, complete coverage would require on the order of ten million additional cell phone towers. Rural cell phone towers are more expensive than urban towers as they are farther from the electricity/data connectivity and they cover fewer potential customers, who generally earn a lower per-capita income. The average rural tower in Asia/Africa costs $385,000 to build. The math is daunting: the additional ten million towers needed to provide coverage to all, at $385,000 per tower, would consume nearly four trillion dollars. No one is willing to write this check. Absent coordinated government activity, tower-based Internet for all will never happen.

47. In contrast, a near-space balloon constellation can start small and scale as demand increases. This new approach is **not** capital intensive, and can be scaled to match growing demand, a significant advantage. This also means that, unlike traditional networks, a balloon network's operating costs will increase only as traffic and revenue increase. This means that a balloon

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network will be profoundly more self-funding than a terrestrial or satellite network. While satellites (with coverage areas hundreds or thousands of miles in diameter) have too **little** capacity and towers (with coverage areas a few miles in diameter) cost too much given the sparse population density, balloons with coverage areas hundreds of miles in diameter make sense. Further, as traffic in an area with balloon coverage increases to the point where a tower becomes economic, towers can be built to offload the capacity of the balloon network, much as Wi-Fi hotspots offload tower capacity today. This balloon approach was, in short, smarter, faster, cheaper, and **realistic**.

***Interoperate With Terrestrial Systems With No New User Hardware***

48. Once Space Data began collecting and analyzing its proprietary wind data, Knoblach and Frische were able to conclude that the winds in the approximately 60,000 to 80,000 foot altitude were the calmest winds, [redacted] If a balloon constellation can provide coverage to a phone in common use, it is much more valuable than a balloon constellation that requires users to purchase a new, particular device to connect. Unlike satellite transmissions, users did not need to buy new dishes or bulky handsets and one balloon constellation could serve all users. Once the LTE protocol became the standard for all broadband smartphones, this meant the balloon constellation could fly with one signal protocol and provide Internet to everyone with a 4G phone. This is one very important advantage to the Space Data balloon network: it works seamlessly and without any additional cost to the users with legacy terrestrial cell-based devices.

**D. Space Data, the Company.**

49. Jerry Knoblach began working on the balloon-constellation communication system idea in late 1996 after years of working in the aerospace communications field.

50. In early 1997, he connected with his colleague from MIT, Eric Frische and, together, they began developing the idea that became Space Data. Frische was an engineer and registered patent agent, as set forth above.

51. In 1997 and 1998, Knoblach and Frische worked to develop the balloon-constellation idea by analyzing wind data and communications protocol to prove that this lighter-than-air network would work.

52. Space Data was formally incorporated in 1997.

53. In June of 1999, Space Data filed for its first patent related to this technology.

54. By early 2000, Space Data was funded, had opened an office, and hired six employees.

55. In 2001, Jim Wiesenberg joined the company as a Chief Strategy Officer ("CSO"). Wiesenberg was a Harvard Business School graduate, as was Knoblach, with deep experience in spectrum acquisition and management.

56. The Federal Communications Commission ("FCC") held a spectrum auction in September 2001, in days after the 9/11 attacks. Space Data bought a significant amount of spectrum at this auction in the 900 MHz band, and owns much of that spectrum today. The spectrum is now worth in excess of $200 million.

57. In 2004, Space Data deployed a number of balloons covering four states, serving oil companies and oil field service companies. Oil wells are often in remote areas, with no landline or cellphone access. But wells and pumps need to be monitored continuously (leaks; malfunctions). Space Data's balloon constellation provided inexpensive, comprehensive network coverage for these remote wells and pipelines. In the years to come, Space Data entered into numerous commercial contracts with such oil and oil field service companies.

58. By 2007, Space Data had nearly 100 employees, a working balloon constellation covering vast swaths of the Southwest, and was building hundreds of proprietary payloads for the U.S. Air Force on a classified project.

59. From 1999 forward, Space Data filed and prosecuted fundamental balloon constellation patents. It now has six issued patents, several more applications with Notice of

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Allowance on file and the patents about to issue, and additional applications pending.

60. Space Data operates balloons that practice its patents. Space Data has commercially exploited the ’941 Patent, a patent-in-suit, by making, marketing, selling, and using products covered by the ’941 Patent, including for example its popular SkySat™ repeater platform, currently being used operationally by the US Marine Corps and US Army, as well as its SkySite™ network that has provided wireless services from a constellation of balloons in the stratosphere on a commercial basis since 2004.

61. Throughout its corporate history, Space Data has worked zealously to maintain the secrecy of its proprietary information. Employees all sign secrecy agreements, the Space Data facilities are security card keyed, all visitors sign in on a mandatory visitor log, and no third party prospective partner was shown proprietary information absent signing an NDA. Space Data maintains a file of these NDA’s in its electronic and hard copy records.

62. Space Data is an active operating business today.

### E. Google’s Space Data Due Diligence.

***Google’s Android Platform and Wireless Neutrality***

63. Apple released the first iPhone in November 2007. Long prior to the iPhone launch, Google understood that search would likely move to mobile devices, migrating away from PC’s and other tethered computers. This was a seismic technological shift, and one that posed an existential threat to Google.

64. As an early part of a multiyear, sophisticated response, Google bought Android in 2005. Android designed and sold a mobile software platform.

65. With Android, Google needed a way to ensure network access for Android-enabled phones friendly to Google and Google apps. But cell (wireless) networks were proprietary; AT&T owns the AT&T network, just as Verizon owns the Verizon network, and so forth. Google planned to release an open platform Google based phone, but was not terribly interested in paying to build its own new cell network. Google essentially wanted the equivalent of net neutrality for devices on the cellular airwaves.

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66. In 2007, the FCC announced that it would auction a very valuable spectrum band, the 700 MHz band, in early 2008. This band is particularly well-suited for wireless cell phone communication.

67. In auctioning spectrum, the FCC has two contradictory goals; (1) the agency wishes to generate as much revenue as possible, but, (2) sees value in having broad and open access to public airwaves.

68. Appreciating this tension, Google lobbied the FCC to include an "open access" provision for the key portion of the auctioned 700 MHz spectrum to be auctioned. That is, the FCC agreed that if a certain minimum bid were submitted, the 700 MHz spectrum would become open to all. The FCC ultimately set that "open access" bid trigger at $6.45 billion.

69. With the auction rules set, Google heavily publicized its intention to bid, hired game theory economists to structure its bid strategy, and participated actively in the bidding process. As largely admitted by Google, and as widely speculated by the other bidders, Google did not in fact intend to acquire the spectrum itself. Instead, Google wanted to ensure that an existing carrier, likely Verizon, would hit the minimum bid, thereby providing Google devices with open network access at no cost to Google.

70. This is precisely what happened. By early March 2008, it was apparent that Verizon had submitted a bid in excess of the minimum, and Verizon subsequently was awarded the 700 MHz spectrum. Google friendly mobile devices are now ubiquitous, and Android-based phones are the most popular phones in the world, outselling iPhones by close to 9 to 1. And, as search moved to mobile, Google's search revenue has increased hugely.

***<u>And So Space Data</u>***

71. This FCC auction and Google's game-theory strategy was important to the early relationship between Google and Space Data. Under the FCC rules, a winning bidder had the obligation to build out coverage to 40% of the population within four years of being awarded the spectrum. For an existing wireless carrier with tens of thousands of towers, this was simply a matter of installing new radios on the towers. For a new entrant like Google, however, losing the spectrum due to missing the construction deadline was a very real risk. If Google's strategy failed,

and if Google actually submitted a winning bid, Google had to honor the buildout requirement. Google understood that it could use the Space Data balloon constellation approach to satisfy its buildout obligation quickly and inexpensively.

72. Nor was this point lost on Space Data. Space Data understood exactly how its technology could aid Google should Google win the spectrum auction.

73. In late August 2007, a Space Data consultant learned of the Google open phone initiative, and emailed Google suggesting that Google should talk to Space Data about incorporating the Space Data balloon technology in Google's open platform strategy, including its planned FCC 700 MHz spectrum bid.

74. On August 10, 2007, Google's Christopher ("Chris") Sacca, then involved in Google's open phone and spectrum initiative, emailed the Space Data consultant, saying "I am curious to hear more about your proposal," and setting a meeting. Contemporaneously, Sacca sent an internal email to several Google engineers, noting the upcoming Space Data meeting, and saying that "Larry Page was interested in us following up."

75. The Space Data and Google executives met on the Google campus (Googleplex) late in the morning on Tuesday, September 18. Chris Sacca and Minnie Ingersoll (*see* ¶ 98 below describing the Google executives in detail) attended for Google; Jerry Knoblach and Space Data Chief Strategy Officer Jim Wiesenberg, attended for Space Data. The Google co-founders, Brin and Page, attended the presentation portion of the meeting. The meeting lasted two and a half hours, and concluded with Google saying that Google was interested in using Space Data's balloon technology to accelerate the buildout of any 700 MHz spectrum Google might acquire.

76. At this meeting, Space Data provided basic and public information on the Space Data platform.

77. Google's Chris Sacca followed up on Tuesday, October 16, 2007. In an email sent to Wiesenberg and Knoblach, Sacca said "we are back on focused with you guys. Stay tuned for a proposal for a next step. Should hear something today."

78. Google Business Development executive Minnie Ingersoll followed up the next day, Wednesday, October 17, 2007. In an email to Knoblach and Wiesenberg, Ingersoll said that

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Google "remain[ed] interested in Space Data." She asked to schedule another meeting to enable Google to do further "technical due diligence," and introduce Space Data to "a few more people on our [Google] team."

79. On Wednesday, October 24, Knoblach and Wiesenberg met with Washington-based Google lobbyist Rick Whitt to discuss Google's open phone platform, upcoming spectrum bid, and a potential business relationship with Space Data.

80. The parties then set a follow-up meeting at the Googleplex for Thursday, November 1. Google's group included Ingersoll, Sacca, and two engineers, Larry Alder and Phil Gossett. Larry Page and Sergey Brin also attended this second meeting. Wiesenberg, Knoblach, and Space Data co-founder and patent co-inventor Eric Frische attended for Space Data. The group discussed Space Data's technology at a fairly general and high level, and likewise discussed how Google might work with Space Data to build out any 700 MHz spectrum acquired.

81. The parties continued to exchange emails following the November 1, 2007 meeting.

82. On November 28, 2007, Google's Ingersoll introduced the Space Data team to Google's Mike Pearson. Pearson was on Google's "Corporate Development Team," and Ingersoll told Space Data that Google was bringing Pearson in as "the right person to help us take this discussion into more formal deal terms."

83. Pearson then scheduled a December 4, 2007 call with the Space Data executives. After that call, Pearson said that Google was interested in going forward, and forwarded a copy of Google's standard Mutual Non-Disclosure Agreement ("NDA"). Google drafted this NDA in full.

84. In the December 4, 2007 call, Pearson asked that Space Data begin to supply confidential and proprietary information to Google to assist Google in its technical and financial due diligence. Pearson first requested detailed Space Data financial information, including the latest "capitalization table, income statement and balance sheet." On the larger business opportunity, Pearson described Google's interest as follows:

> The most critical piece of information however will be getting some sense from you and the team about what you would envision as being the potential uses for the balloon technology here at Google. If you remove the constraint of having to find near term monetization opportunities, what are the areas that you and the

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> team would like to focus on at Google? **I think the easiest way to flesh it out is to look at opportunities that do and do not involve Google owning a large block of spectrum in the near term and what are the goals you would like to accomplish in either scenario.**

(Emphasis added). In this way, Google moved beyond the spectrum buildout relationship to a general acquisition; Pearson's job at Google was to evaluate early stage companies as potential Google acquisitions.

85. On Friday, December 14, Space Data provided to Google detailed Space Data financial information. Specifically, Space Data provided its five-year going-forward projections (more than 2,000 pages). In a separate email on the same day, Space Data provided its audited actual financials for the prior three years and, in aggregated form, financial for the prior years since inception of Space Data in 1997. These financial reports set forth the exact economic picture of the company over time, including capital expense, operating expense, reserves, debt, investment, and the like. These confidential reports and models provided the big picture and intimate detail, scope and scale, revealed valuable successes and costly expenditures, forward looking goals and interim milestones to Google. Historical numbers provided proof and projections provided strategy and expectations. Details in the pro-forma embodied and summarized a great deal of the wisdom accumulated through careful, multi-year planning, effort and expense by Space Data and its investors. The cover email explicitly stated that all of the financial information, past, present and future, was proprietary, confidential, and fully subject to the NDA. A subset of the proprietary financial information sent to Google under the NDA is attached hereto as Exhibit D and incorporated herein by reference.

86. In mid-December, Google's Chris Sacca left Google, and went on to significant notoriety as an angel investor (Instagram; Twitter).

87. Ingersoll reviewed the information provided, and responded by email to Space Data on Thursday, December 20, 2007:

> **We are making a lot of positive progress getting our head around the financials of Space Data, but I'd like to schedule some time for a followup with our technical team to do more due diligence about the Space Data constellation. Can we**

**schedule time with you to review the balloon technology in more detail when we get back to work in Jan?**

88. The parties so scheduled a technical conference call for January 3, 2008. At this point, the Google evaluation team had grown to seven people, including multiple engineers. The call was attended not only by this team, but also by the founders of Google.

89. On January 2, 2008, Space Data sent Google proprietary and confidential "vision" slides which detailed the concept of a worldwide network of balloons providing Internet coverage, and a plan for how to do it.

90. By late January 2008, Google and Space Data were discussing a range of valuations for a Space Data-Google acquisition. As part of this process, Space Data forwarded on January 25, 2008, a 2007 year-end Space Data (pre-audit) P&L. This document was marked as confidential pursuant to the NDA.

91. By the end of January, Google had evaluated Space Data's technical and financial information and wanted to schedule a full day technical inspection and due diligence visit at the Space Data headquarters in Chandler, Arizona (a Phoenix suburb). This meeting was subsequently set for February 15, 2008.

92. On January 28, 2008, Space Data forwarded a 600 page WiMax (network) financial model to Google.

93. On February 5, 2008, Space Data executives had another conference call with Google's Mike Pearson.

94. On Monday, February 11, Space Data's C.E.O. Jerry Knoblach forwarded a detailed analysis on how Google could use Space Data's spectrum paired with other spectrum available for lease in the Air to Ground band "to provide service to GSM equipment operating on the standard 900 MHz band used for GSM elsewhere in the world." The proposal provided a quick and inexpensive way of providing capacity for GSM mobile phone handsets, and GSM was the most prevalent cellphone handset in the world at the time.

95. On February 12, 2008, Knoblach forwarded to Pearson a PowerPoint presentation summarizing Space Data's forecast and revenue projection for Space Data. The document set out

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the details of Space Data Government contracts, including details of the United States Air Force's use of Space Data balloons in Central Iraq. The document also set forth the economics and Space Data margins on this contract. The document further set forth Space Data's prospective military opportunities. The cover email notes that the attachment was "confidential under the terms of our NDA," as does every page of the underlying document itself.

96. Just days prior to the in-person meeting in Chandler, Arizona, Google's Daniel Conrad forwarded a series of detailed questions concerning Space Data's valuation, particularly given events that occurred in recent spectrum auctions.

***The Google Team Comes to Space Data***

97. On February 15, 2008, twelve Google executives and engineers, including the two cofounders, flew to Arizona and then traveled in several SUV's to the Space Data Chandler facility. The group spent the better part of a day at the facility.

98. The following executives and engineers attended for Google:

- **Sergey Brin**: Mr. Brin is a Google cofounder, and a C.S. engineer by training.
- **Larry Page**: Larry Page is the other Google cofounder, and also a C.S. engineer by training.
- **Larry Alder**: Larry Alder is an engineer with advanced degrees in aeronautics and astronautics. He joined Google in 2005. For approximately 12 years, he lead Google's "Business Operations Access Group," which houses Google initiatives "promoting open internet access." He has worked closely with Minnie Ingersoll, described below, since he joined Google in 2005.
- **Minnie Ingersoll**: Ms. Ingersoll has an MBA and B.S. in Computer Science. She joined Google in 2002. From 2002 to 2011, Ms. Ingersoll worked as a Google products manager, leading efforts to broaden internet access for all, including Google's work with Space Data, Google's work on Google fiber, and like projects. She co-founded the Access team; a cross-functional product, policy and engineering team. She was a Principal at Google from 2011-2014.

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- **Daniel Conrad**: Daniel Conrad is an engineer, and served as an early member of the Android and "Access" teams at Google. He was a Google Project Manager from 2006 to 2010. The Google Access team is dedicated to providing internet access to all.
- **Daniel McCloskey**: Mr. McCloskey is an engineer, and an inventor on numerous patents, often with Phillip Gossett (*see* below) as a co-inventor. He joined Google in 2007. Mr. McCloskey's expertise appears to lie in network communications. For several years, Mr. McCloskey served as Head of Design for Google's Advanced Technologies and Projects Group.
- **Phillip Gossett**: Mr. Gossett is an engineer and co-holder of patents with McCloskey. Mr. Gossett has been a Senior Staff Software Engineer at Google from 2005 to the present.
- **Richard Walker**: Mr. Walker worked as a Google engineer from 2007 to 2010.
- **Sunil Daluvoy**: Mr. Daluvoy has a Bachelor's in Science and a law degree. From 2006 to 2013, he worked on New Business Development at Google. Mr. Daluvoy is currently Head of Business Development at Uber Technologies. While at Google, he worked with Business Development and "Access," the group charged with improving internet access for all. He was also involved in the Google spectrum auction. From 2006 to 2011, he was a senior executive in Google's New Business Development Group.
- **Mike Pearson**: Mr. Pearson joined Google in 2005. Mike Pearson was a general partner at Google Capital, Google's in-house venture entity. He also worked as a Director, Corporate Development, on Android projects at Google. As a partner at Google Capital, Pearson focused on early stage acquisition opportunities for Google.
- **Joseph S. Faber**: Mr. Faber is a lawyer, and joined Google just prior to the 2008 spectrum auction. He has deep FCC regulatory experience, including working with AT&T. He currently serves as a senior Google in-house lawyer.

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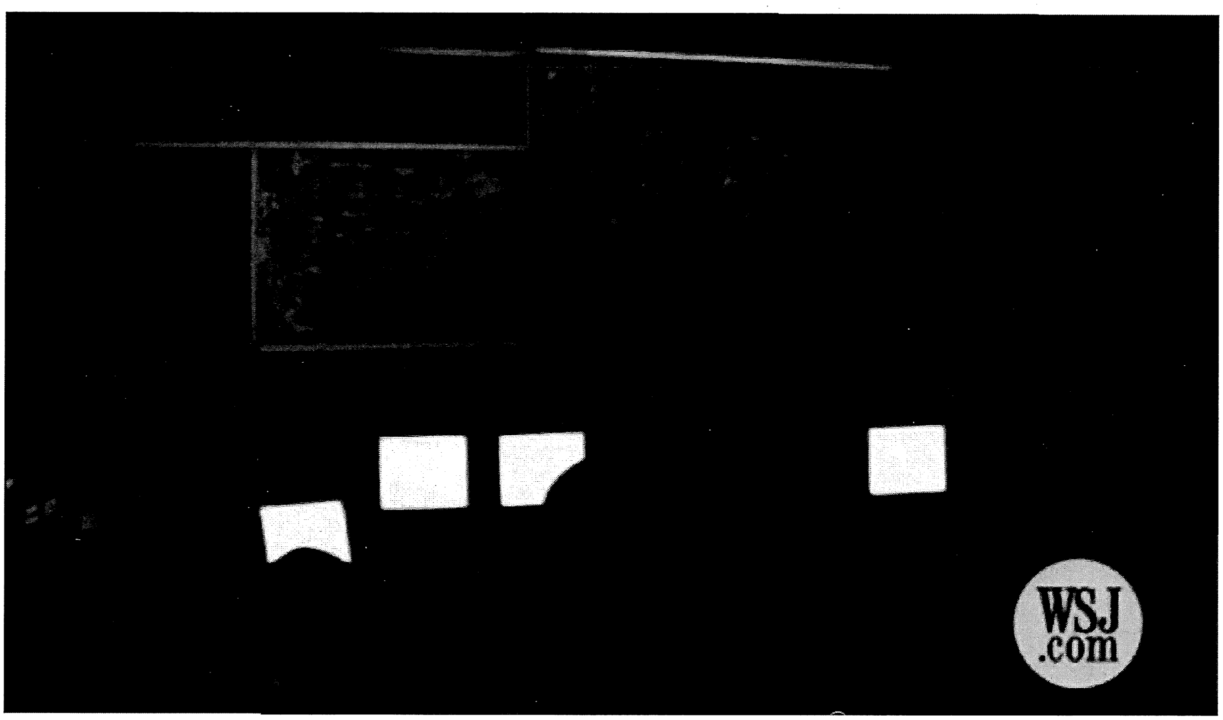
99. The Google team arrived at approximately 10:45 a.m. They were first given a tour of Space Data's balloon manufacturing facility, where Space Data walked the group through the precise mechanics of the Space Data balloon construction process.

100. The group then went to the Space Data Network Operations Control ("NOC") Center. The NOC is essentially Space Data's Mission Control, the group monitoring all Space Data balloons and balloon arrays.

101. The Space Data NOC had, at that time, two large projected screens on the wall, one [redacted]

102. Here is how the Space Data NOC looked (at a distance with data obscured) in February 2008:




103. In addition, the Space Data NOC contains multiple computer monitors (in white above) on desks arranged in a U shape with a dozen monitors, each tracking various aspects of a balloon flight, as described in detail below.

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104. When the Google due diligence team arrived at the Space Data NOC, [redacted] This was a real balloon array, providing real-time data and network coverage, all for real customers.

105. The Google team took photographs of various Space Data gear, including screenshots of the Space Data data on the NOC monitors, as set forth below. The Google team spent over an hour in the NOC asking questions, asking how balloon trajectories are controlled, asking to see the various screens NOC operators controlled, and asking how wind alone is used to maintain the spacing of the array of balloons. [redacted]

106. From the NOC, the Google team walked 50 feet outside to launch a balloon. [redacted]

107. After the launches, lunch was served in the main conference room. Metadata on photos record that by approximately 1:53 p.m. lunch was over and the tour was in the production area examining the detailed construction of the internal components of the company's balloon payloads and watching monitors displaying real-time data of the two balloons launched before lunch. [redacted] Thus, Google was able to observe and photograph the company's proprietary flight control software in operation for over an hour in the NOC and over an additional half hour in the production area.

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108. Space Data knows this to be true, as it has pictures of the Google founders and Google photographers, including a picture of a visibly entertained Sergey Brin personally releasing a Space Data balloon, as set forth below:

***The Founders at Space Data***

***The Brin Release***

***Google (Daluvoy Here) Photographs the Space Data Screens***

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***The Type of Camera Used: a High Resolution Nikon(s)***


***Google Visit to Space Data With Private Property Posting***

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***Google Reviews the Payload Details***

***The Cameras***


109. Space Data has dozens of images documenting the various aspects of Google's Space Data tour and technical due diligence.

**F. Trade Secrets Disclosed to Google.**

110. Both before the February 15, 2008 tour of Space Data, and during that tour, Space Data provided proprietary, confidential, trade secret information to Google under the NDA. Before the meeting, Space Data sent Google detailed financial models and projections as well as presentations describing just how a worldwide, ubiquitous, balloon-based communications network would work. During the visit, Space Data gave Google access to restricted areas and proprietary information which Space Data keeps closely guarded. Following the meeting, on February 19, 2008, Space Data sent Google an email summarizing the confidential information that had been disclosed during the visit and designating it as confidential. As described below (in section G), under the NDA, Google could not use the information disclosed for any purpose other than to "enable the Parties to evaluate the feasibility of a business relationship" of a proposed acquisition of shares or assets of Space Data. *See* Ex. A, NDA, § 2.

***Confidential Information Disclosed During the February 15, 2008 Visit***

111. The following paragraphs recount what Google saw during its visit to Space Data and why that proprietary information mattered. [redacted]

***Structured Wind Data in the Peaceful Band***

112. As one example, reproduced below is the wind data screenshot for Space Data [redacted]

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*See* Exhibit C, a compilation of screen shots of the flight data on display on February 15, 2008, which is attached hereto and incorporated herein by reference.

113. [redacted]

114. [redacted] These data prove the existence of discrete and structured wind patterns in the stratosphere, a key predicate to making an airborne balloon constellation work. With structured wind patterns, one can fly a balloon array; without, one cannot.

115. The wind data that Google saw in its tour represented proprietary and trade secret Space Data information. Space Data had laboriously assembled such wind data over literally hundreds of thousands of hours of flight time. The Space Data information contradicted the information then in the public record and was not disclosed in the '941 Patent. [redacted] Space Data explained this point in detail to Google at the Space Data facility, and showed Google many examples on the screens, with the screenshots proving Space Data's point correct.

116. This wind data epiphany matters in flying a balloon constellation intending to provide broadband wireless coverage to standard smartphones. [redacted]

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[redacted] the highly structured (stratified) winds in the peaceful band. These epiphanies, and the data supporting their legitimacy, are all Space Data trade secrets, were not in the public domain, and were disclosed pursuant to NDA to Google on February 15, 2008.

117. This data also showed Google that Space Data's idea was not a hypothetical "beam me up Scotty" assertion, but a proof of principle based on real data recording a real flight, as captured in screenshots from the NOC. Over the course of its visit, Google saw similar data for every one of the balloons in the constellation then flying. All-in, Google saw and could photograph hundreds of similar screenshots covering every balloon in the array for a period exceeding an hour and a half. *See* Ex. C. This was a robust set of data indeed and available nowhere else on earth other than in the company's NOC and secure air-gapped servers.

***The "Hover" Algorithm***

118. Contrary to conventional wisdom, [redacted]

119. Space Data proved this conventional wisdom wrong. Before Space Data's hover algorithm, all balloons flown in the stratosphere were zero pressure balloons, which means the neck is open and as a balloon rises above its float altitude excess lift gas simply spills out of the neck or very rigid balloons that did not expand much as they ascended.

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120. For each balloon flight on February 15, 2008, Space Data implemented its hover algorithm, and reflected the input data and resulting balloon behavior on the "hover" screenshot.

121. The hover screenshot is reproduced below:

[redacted]

122. From this screenshot, an engineer experienced in predictive feedback systems and controls would know what Space Data did in its hover algorithm, [redacted]

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[redacted]

123. This was not another abstract, "beam me up Scotty" assertion, but rather real data reflecting real behavior of balloons in a real constellation in commercial service real-time.

***Thermal Management***

124. The ambient temperature in the peaceful band is approximates negative 40° Fahrenheit. Counter-intuitively, one of the principal challenges to making a stratospheric balloon constellation work is thermal (heat) management. At 60,000 plus feet, the air is very thin, and extremely ineffective at conducting heat away from the balloon payload. As is true for all electronics, the electronics in a balloon (particularly the power amplifier ("PA")), generate heat. More, while the PA is hot, and reducing heat is an issue, the GPS instrumentation, which sits higher in the payload, tends to be very cold.

125. After significant experimentation, Space Data learned how to manage thermal heat regulation in the stratosphere. [redacted]

126. During the Space Data tour, Space Data explained its thermal management techniques, and solutions generally, to Google at great length. These, too, were trade secrets. A skilled engineer with photos of the inside of Space Data's payload as well as data from the NOC screens (relating to power consumed and temperature) could reverse engineer Space Data's thermal management designs.

***Space Data's Proprietary NOC Altitude Control and Monitoring System***

127. As another of the many screenshots monitored for each balloon monitored in flight, [redacted]

128. [redacted]

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[redacted]

*See* Ex. C.

129. In viewing these screens, Google was able to see (and capture with its camera) the specific types of data Space Data captures, monitors, and analyzes for each flight from its NOC. A knowledgeable engineer would be able to use this information to reconstruct Space Data's proprietary altitude control and monitoring systems, as Google has done in its own "Mission Control" described below.

130. Google's current Loon Mission Control bears a striking similarity to Space Data's NOC:

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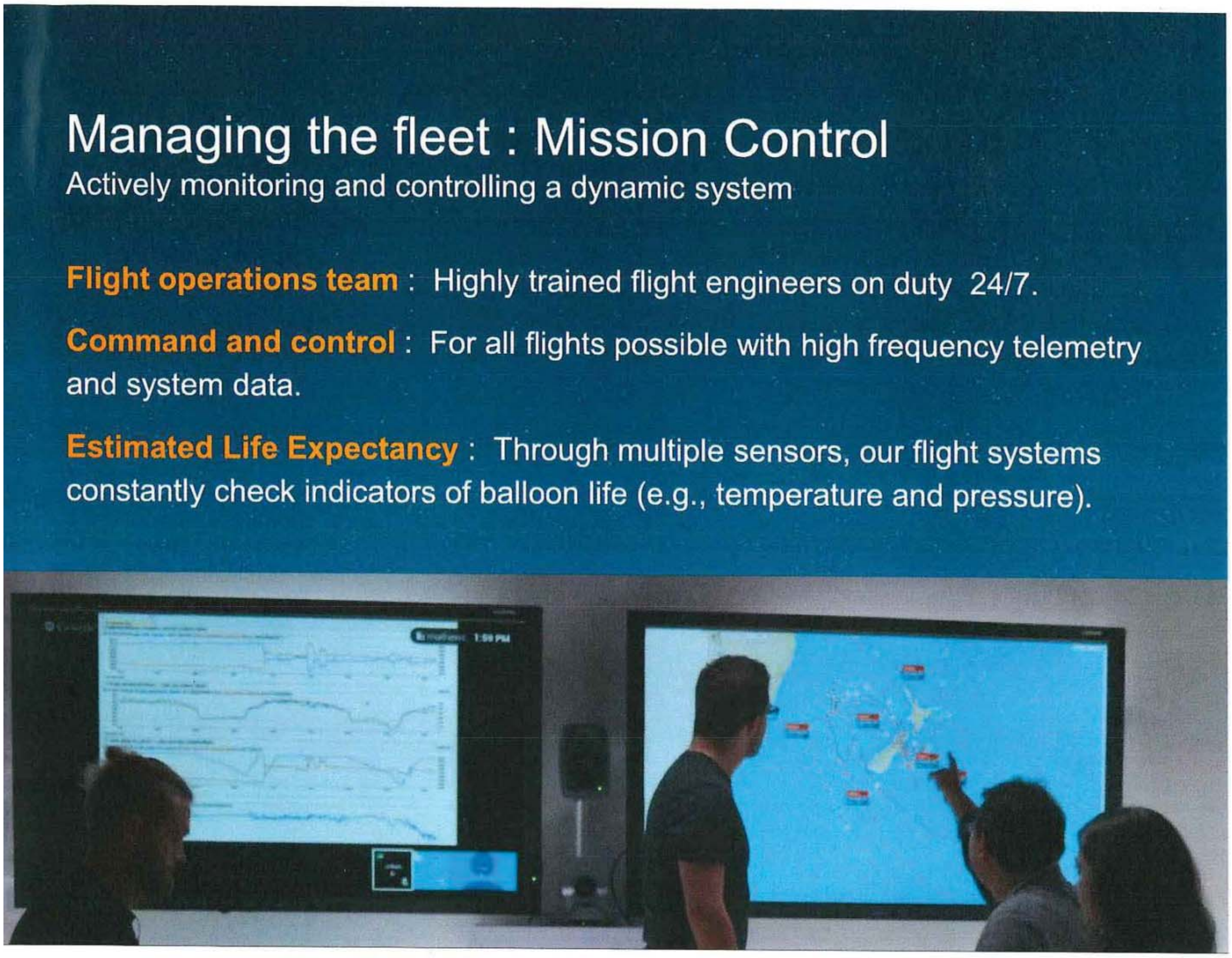
Managing the fleet : Mission Control
Actively monitoring and controlling a dynamic system
Flight operations team : Highly trained flight engineers on duty 24/7.
Command and control : For all flights possible with high frequency telemetry and system data.
Estimated Life Expectancy : Through multiple sensors, our flight systems constantly check indicators of balloon life (e.g., temperature and pressure).

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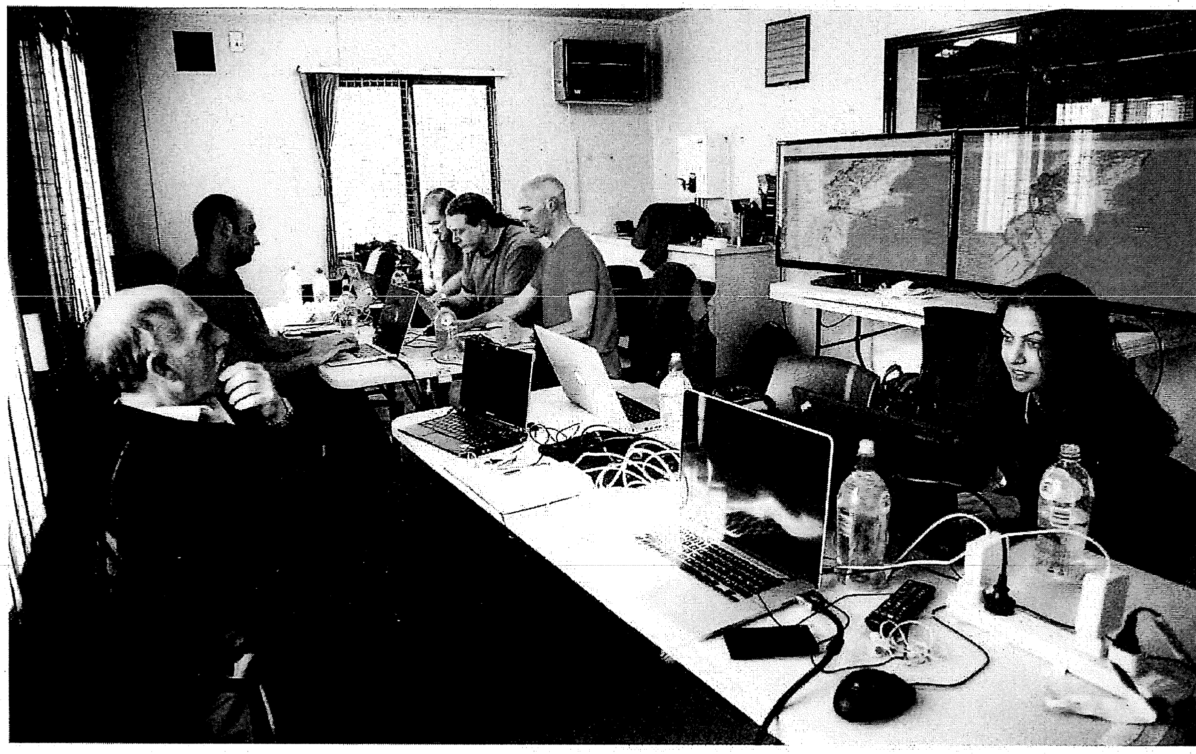

***The Economics: This Was Not a "Moonshot," But a Real and Viable Commercial Enterprise***

131. In addition to the flight information Space Data shared with Google (under the NDA), Space Data gave Google over 2,000 pages reflecting Space Data historical financial performance and future projections, as described above in paragraph 85. *See also*, Ex. D.

132. From this financial data, Google could see all the economic aspects of the Space Data business. Google would have known, for example, what it costs to set up and run the Space Data balloon constellation. [redacted] The trillions of dollars required to construct towers (as discussed above) to cover the rest of the world's population was over ten times Google's entire market capitalization in 2013.

133. Space Data's economic data was also valuable in that it showed detail on the main cost drivers in the logistics cycle of providing service from balloons including: [redacted]

[redacted] Not only were the actual costs for each step of this process shared with Google, the models contain the mathematical relationships to vary assumptions for each step of the process to run sensitivity analysis to understand the operational costs and how they can be modified. These basic mathematical relationships, costs and improvements with experience are very useful for modeling all types of balloon-based wireless services businesses. Space Data's network may be a regional network, but by changing some parameters in the model, it can be scaled to model a broadband network covering an entire nation, an entire continent, or the entire world. And Space Data explained all of this to Google.

134. This economic data were of very real value to Google. Although Google's pockets are deep, Google has emphasized publicly that it will not green-light Google X "moonshot" projects unless *it has the conviction that the projects would likely be economic and commercially viable*. As Google put it recently:

> **Thinking about X as a portfolio**
>
> Being a "corporate lab" is a difficult balancing act: place big bets on the future, but don't spook the people giving you the money. As an Other Bet (one of the Alphabet divisions that's not Google), we want to be good stewards of the resources invested here and deliver a good return so that we're trusted to keep the factory open for years to come.
>
> We look for opportunities to balance X's overall portfolio sensibly, and aim for diversity: a mix of hardware and software, a mix of industries and problems, a mix of ideas that will take more (closer to 10 years) or less (closer to 5 years) time to have an impact. We have clear budgets and limitations; we can aspire to creating significant growth for Alphabet without significantly growing ourselves.

https://blog.x.company/a-peek-inside-the-moonshot-factory-operating-manual-f5c33c9ab4d7

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135. The Space Data technical information, coupled with the detailed Space Data economic information, would have proven that the Loon project was commercial, feasible, and worth Google's investment.

***<u>Space Data's Worldwide Balloon Communications Network "Vision" Slides</u>***

136. Not only did Space Data provide Google financial models before the February 15th visit, but Space Data also provided Google "vision" slides, marked as proprietary and confidential, which laid out how Google could develop a worldwide constellation of balloons to provide ubiquitous Internet coverage, and how to make this work (*i.e.* the idea Google later called "Project Loon").

[redacted]

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[redacted]

**G. <u>The NDA</u>.**

137. As described above, the parties entered into an NDA, effective as of December 1, 2007, for the purpose of engaging in "discussions and negotiations concerning a proposed acquisition of shares or assets" of Space Data. This was the only permissible use of the Space Data information.

138. The NDA expressly stated that "it is anticipated that the Parties will disclose or deliver to the other Party certain trade secrets or confidential or proprietary information and Google and [Space Data] are entering into this Agreement in order to ensure the confidentiality of such trade secrets and confidential or proprietary information…." *See* Ex. A.

139. The NDA required that confidential information be clearly marked or identified as confidential by the party disclosing the information, a requirement Space Data met with every trade secret category described above in section F.

140. After the NDA was signed, Space Data provided Google with access to Space Data's confidential and trade secret information, all of which Google was required to "hold in confidence." *See* Ex. A § 4. The NDA also prohibited Google from using any confidential

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information disclosed by Space Data except for the purpose of "enabling the Parties to evaluate the feasibility of a business relationship" or the acquisition of Space Data by Google. *See* Ex. A. § 4.

141. The terms of the NDA expressly provide that this agreement would remain in effect until terminated by either party with thirty days prior written notice, and that the agreement shall "survive with respect to Confidential Information that is disclosed before the effective date of termination." See Ex. A § 6. As of today, Defendants have never provided any such notice of termination.

142. Despite Google's express agreement to the terms of the NDA, Space Data is informed and believes that Defendants have developed Google Loon based on Space Data's confidential and trade secret information, in breach of the NDA, as set forth below in sections H and I.

143. As Google was only permitted to use Space Data's trade secrets and other confidential information in order to evaluate Space Data as an acquisition target (or business partner), Google's evident use of Space Data's proprietary financial modeling confidential business plan for a worldwide balloon constellation network, and information derived from access to Space Data's proprietary wind data, hover algorithm, thermal management system, altitude control system, and network operations center to develop Project Loon, constitutes a breach of the NDA.

144. Google's disclosure of certain of Space Data's trade secrets and confidential information in Google's patent applications and asserted "ownership" of Space Data's intellectual property is also a breach of the NDA as it violates section 8, which states that "[n]o Party acquires any intellectual property rights under this Agreement[.]" *See*, Ex. A, § 8.

145. Google's continued use of these trade secrets contrary to the NDA, Google's assertion of ownership over Space Data's trade secrets, and Google's disclosure of certain trade secrets constitutes misappropriation of Space Data's trade secrets under the California Uniform Trade Secrets Act and the Defend Trade Secrets Act.

146. As described more fully below, Google's Project Loon echoes not only Space Data's patent, but also the confidential, trade secret information provided to Google under the parties' NDA.

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**H. Google's Project Loon.**

147. According to Google's public statements, Project Loon came into existence as follows:

148. In mid-2011, Google hired Richard DeVaul, an engineer previously working at Apple Computer.

149. DeVaul joined Google's experimental research group, known as X (formerly known as and/or referred to as "Google X" or "Google X Lab" or "Google[x]"). At X, DeVaul worked with X's Rapid Evaluation Team, a group responsible for quickly ascertaining the viability of proposed research projects.

150. According to Google, the Rapid Evaluation Team's job is to kill as many ideas as quickly as possible. Prove to us, says Google, that these bizarre, "moonshot" ideas will **not** work.

151. And Google X was not just a research lab for moonshot ideas. As Google's Mike Cassidy explained "[v]ery early on in the [Google Loon] project analysis it had to be a viable business model . . . . And they are tough on the business model."

152. Eric "Astro"[1] Teller ran Google X when DeVaul joined the organization. DeVaul reported to Teller, and Teller reported to Page. Both Brin and Page had offices at X.

153. As one of DeVaul's first assignments, Teller asked DeVaul to assess the viability of a balloon borne internet constellation. According to Google, this directive came directly from the cofounder and then C.E.O. Larry Page, whom Google reports had been fascinated with the idea of a balloon internet constellation for several years.

154. DeVaul began working on the project, and Google reports that DeVaul soon had his first epiphany: rather than huge powered and stationary balloons, why not a gaggle of smaller balloons, all inexpensive and quickly landed and replaced?

---

[1] The name evidently refers to his haircut in high school, which looked like Astroturf, not a background in astrophysics.

155. The problem, said Google, was that there was no way to steer or control an array of such unpowered balloons. Even if launched in proximity, Google believed that they would soon drift apart, destroying the constellation and unraveling the airborne internet.

156. DeVaul's second epiphany, according to Google, lay in mapping the micro-wind currents in a calm band in the stratosphere. DeVaul realized that Google could essentially "sail" balloons in an array once these micro-wind patterns were understood.

157. DeVaul further realized, again according to Google, that Google could control the **horizontal** placement of the balloon by adjusting its **altitude**, up or down, to catch a different wind stream to move the balloon to the desired horizontal location (later a claim Google repeatedly patented as a novel and innovative Google invention!). *See* below, § I.

158. Google launched its first test balloon in August 2011. The balloon consisted of a simple latex balloon envelope, and a basic Wi-Fi transceiver payload. Google called this first generation balloon the Pterodactyl, and it is depicted below:

159. And another shot:

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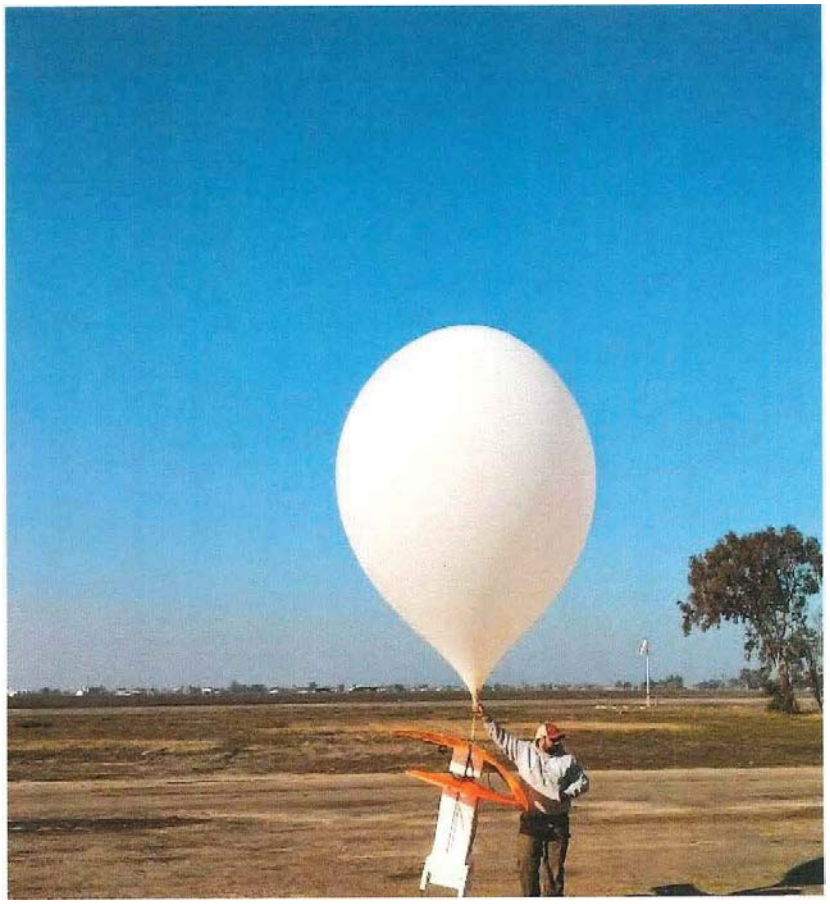

160. These early Loon balloons are strikingly similar to the Space Data progenitors as shown below with the National Guard launching one of Space Data's balloons.

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161. DeVaul tethered a small Wi-Fi transceiver to the balloon. This transceiver could communicate with receivers on the ground.

162. The Pterodactyl test worked, proving in principle that airborne balloons could create a working internet link.

163. Over the remaining months of 2011, Google continued to launch new balloons. By the end of 2011, Google had discovered (it says) that the balloon constellation worked, with one balloon receiving feeds from other balloons, and then transmitting the feed to the ground-based receiver. Google thereafter patented this idea too.

164. In these early tests, Google's Loon payload tended to land in an uncontrolled fashion. To aid retrieval and assuage anxiety, Google attached a label to each Loon payload, saying "**Harmless science experiment: call Paul [at the number below] for a reward.**" Google later applied for and received a patent on this novel "retrieval mechanism," *i.e.*, having an "if found, please call" label, something Space Data had been doing for years and was on the payloads Google took photos of while touring Space Data.

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165. From 2011 through June 2016, Google launched and landed nearly a thousand Loon balloons. It accumulated hundreds of thousands of hours of flight time, collecting wind data, and further refined its balloon constellation and electronic configurations.

166. In June 2013, Google had its first public balloon launch in New Zealand, a country selected given friendly airspace coupled with confidentiality and vast tracks of thinly populated land. To wide press coverage, the launch worked, providing internet access to several sheep farmers in the New Zealand hinterlands.

167. In January 2012, Google filed the first of what would become approximately 102 Project Loon patents and applications. These early applications claim basic aspects of a balloon borne network constellation as organic Google inventions, even though these ideas had long prior been either disclosed to Google by Space Data or previously patented by Space Data itself. *See* below § I.

168. Over the years following, Google has refined its balloon constellation and payload design and circuitry. Google now buys its balloons from Raven Aerospace, a Texas company with its principal place of business in Sulfur Springs, Texas. Space Data signed an NDA with Raven on August 19, 1999, and presented the patented constellation of balloons for communications to the C.E.O. of Raven shortly thereafter. Raven is contributorily infringing.

169. Google's current Loon design "uses super-pressure balloons equipped with limited altitude control systems." Specifically, air is used as ballasts, and pumped into or out of an enclosure within the balloon, known as a Ballonet. This approach allows "the balloon to modify its weight for ascent or descent." Google characterizes the advantages of this altitude control as follows; "These altitude changes allow the balloon to take advantage of different wind patterns at different altitudes for navigation…. Modeling how a balloon will fly at different altitudes is a significant technical achievement for the project, and Loon is constantly improving our predictive abilities."

170. The current Google balloon is made of polyethylene, weighs 55 kilograms, is 60 feet high and 15 feet wide, and is equipped with at least two independent redundant flight termination systems (described below) and a parachute tethered to the payload. While Space Data

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has not employed polyethylene balloons due to their environmental impact, Space Data's patent claims are general enough to cover a wide range of balloon types.

171. The Loon balloons carry communications and safety equipment, including a flight computer, batteries, solar panels, environmental sensors, transponder, a GPS receiver, and iridium satellite communications link, and a parachute. Some of the Google Project Loon balloons also "carry communication equipment to conduct operations with local telecommunications companies…."

172. Google currently launches balloons principally from the United States (adjacent to the Winnemucca Nevada Municipal Airport and the José Aponte de la Torre Airport in Puerto Rico) and a small number of additional sites.

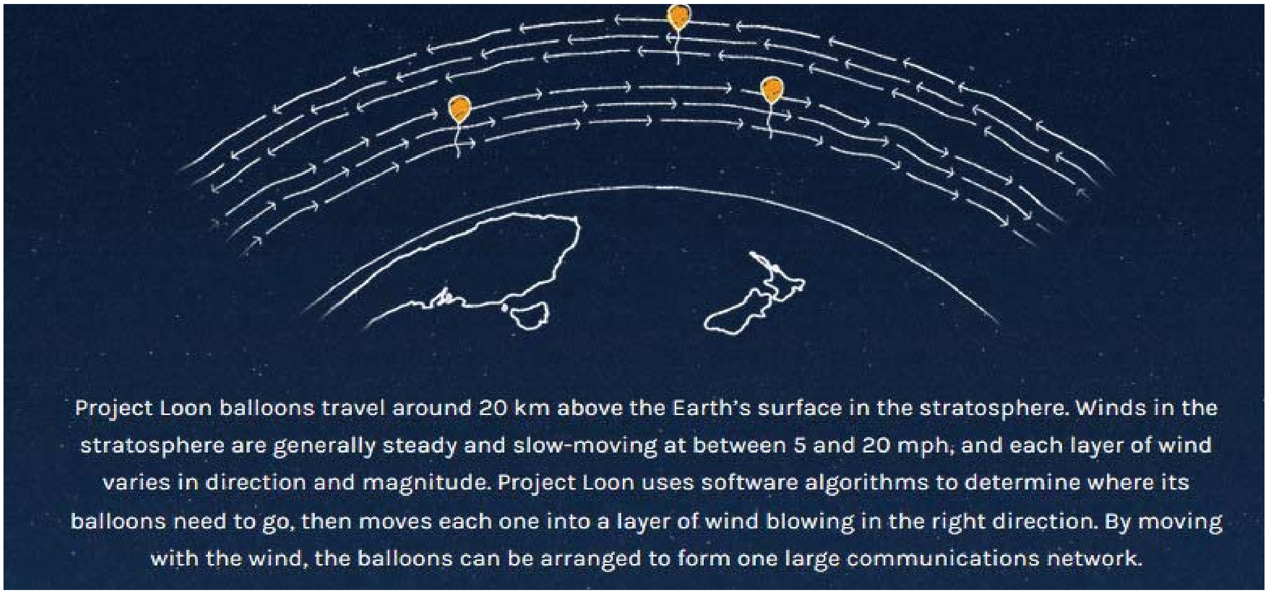
173. Google has recently reported that it is in commercial discussions with several large telephone carriers to provide Loon internet coverage.

174. On information and belief, Google is spending approximately $1 million a day on Project Loon.

***<u>Google Copies Space Data</u>***

175. In describing Loon and the underlying technology, Google's engineers made plain the eerie similarity between Loon and Space Data. To quote Google:

***<u>On Sailing With the Micro-Currents</u>***




www.google.com/loon/how/

This is Space Data sailing in the peaceful band exactly.

***On Controlling the Array***

176. "Since the balloons drift with the wind, Google engineers devised a system to raise or lower them in order to catch the air currents needed to keep them floating just the right distance from each other – and aligned so if one floats out of range from Internet users in a particular region, another will come along and take its place."

**Source:** http://www.mercurynews.com/2013/07/26/google-thinks-balloons-may-solve-problem-of-internet-access-in-third-world/

***On Loon to Earth Communications***

177. Here is a Google depiction of how its own constellation communicates:

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Each balloon can provide connectivity to a ground area about 40 km in diameter at speeds comparable to 3G. For balloon-to-balloon and balloon-to-ground communications, the balloons use antennas equipped with specialized radio frequency technology. Project Loon currently uses ISM bands (specifically 2.4 and 5.8 GHz bands) that are available for anyone to use.

**Source:** www.google.com/loon/how/

***On the Choreography: the Loon "Dances"***

178. "Loon is a network of free floating stratospheric balloons. Now if the balloons just floated entirely free, they would eventually drift to either pole and that wouldn't be terribly useful." - Rich DeVaul, Google Innovator." **Source:** https://www.youtube.com/watch?v=F8QeQLf53Cw

179. "You have these two free floating platforms that are kind of swaying and bobbing freely, a dance, if you will between the two balloons…." – Baris Erkmen, Technical Lead, Project Loon." **Source:** https://www.youtube.com/watch?v=BEC0G2HbuiE

***On Working With the Legacy Infrastructure***

180. One of Google's most important Loon epiphanies was that its network could communicate seamlessly with the legacy terrestrial infrastructure, a huge advantage:

> We've established gigabit per second connectivity between the balloons up in the stratosphere, hundreds of kilometers apart getting the signal down to the user. We're using LTE, so you can just use the same mobile device you used today to get service whenever there's a loon balloon floating by. All of this technology coming together will allow someone

> who could be thousands of kilometers away from the nearest ground infrastructure to have access to the Internet. – Baris Erkmen, Technical Lead, Project Loon

**Source:** https://plus.google.com/+ProjectLoon/posts/LAc5SVq9wyj. This concept, too, Space Data discussed with Google.

***On the Hand-Off, Balloon to Balloon***

181. "The idea is to have enough balloons so as one balloon floats out of you area, there's another balloon ready to float into place, handing off the internet connection." – Astro Teller, Captain of Moonshots, Google X. **Source:** https://www.ted.com/talks/astro_teller_the_unexpected_benefit_of_celebrating_failure/transcript?language=en

182. "[S]o another balloon is coming just at the right time to take the place of the one that left." – Mike Cassidy, Project Lead, Project Loon. **Source:** https://www.youtube.com/watch?v=HOndhtfIXSY

***On the Loon Balloons***

183. While the current "Night Hawk" Loon balloon differs in construction, this is not a case about how one constructs a balloon; it is, instead, a case about how one makes a **balloon network** work. But many aspects of the Loon balloons overlap with the Space Data progenitor, as set forth below:

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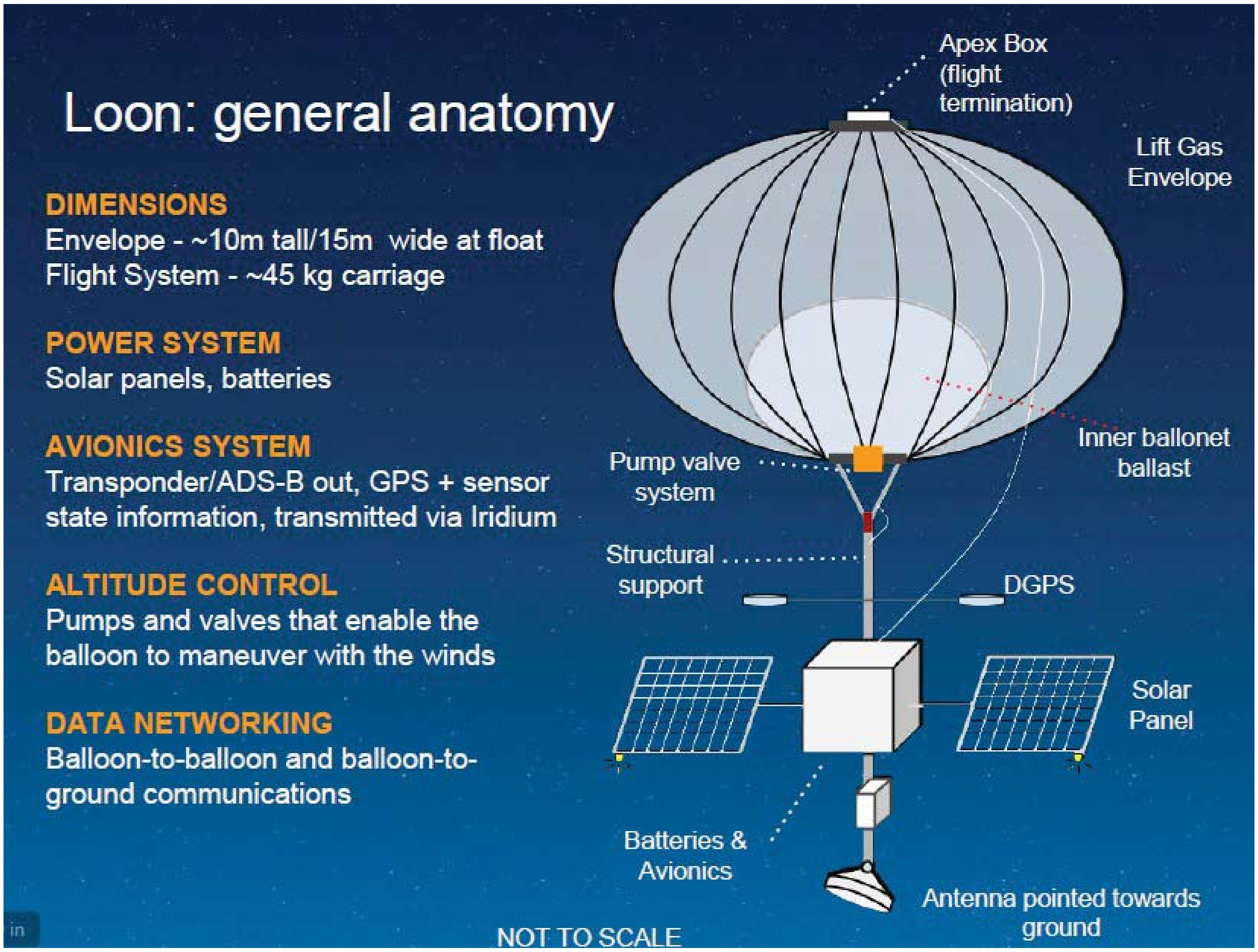


**Source:** www.google.com/loon/how

***On the Inner Air Bladder***

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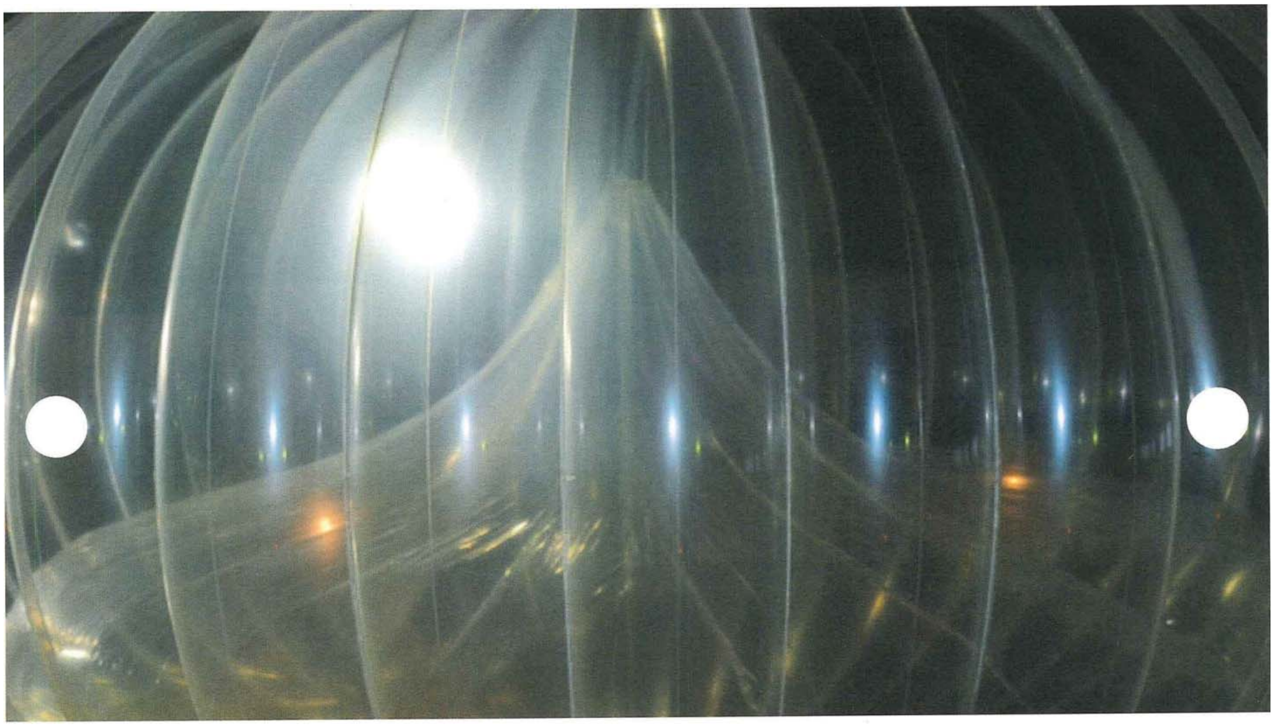


***On Google's Current and Commercial "Night Hawk" Balloon***

***Page Takes Credit for Google***

184. Google's co-founder Page, who visited the Space Data facility and **saw** the stratified wind data, described this exact point as something Google had discovered:

> **[B]ut it turns out, we did some weather simulations which probably hadn't really been done before**, and if you control the altitude of the balloons, which you can do by pumping air into them and other ways, you can actually control roughly where they go, and so I think we can build a worldwide mesh of these balloons that can kind of cover the whole planet.

www.ted.com/talks/larry_page_where_s_google_going_next/transcript?language=en.com

185. Page was at the early Space Data meetings, he saw the data, he learned this from Space Data, he worked at X, and yet he said this was all Google's idea.

186. And Google's own statements during its New Zealand launch of Loon likewise describes the information. Google again claims information learned from Space Data as something Google discovered:

> This is a secret project that we've been working on for two years, and this is a project that our team is so excited to be launching here in New Zealand. This is what the balloons really look like. It's an experimental technology. The balloons fly twice as high as commercial airplanes. 20 kilometers up in the sky. This is what's gonna help us bring internet access to some of the 5 billion people around the world who don't have it. It truly fits our definition at Google X of moonshot. **It's a huge problem, the solution is radical, and it took significant technology breakthroughs to get there.**
>
> **One of the technology breakthroughs is the way we control the position of the balloons**. In the past, others have thought about ways of providing communication from a high altitude platform. And they thought of maybe tethering the balloon to the ground, which has obvious issues of aircraft collisions. Or they thought of a platform that was continuously fighting against the wind to stay in one place above the ground. **But instead we thought, what if you don't have to stay in one place. What if you have one balloon sail with the wind and another balloon come and take its place**.
>
> We thought, is it better to be friends with mother nature instead of fighting against mother nature? ***
>
> By changing how we thought about the problem, by deciding that instead of maybe a small number of large, expensive things staying in one place, providing the internet to one area, maybe we could have a large number of free-floating, **inexpensive, high altitude balloons, that would drift with the winds**, not fight them, and provide the internet all around the world.
>
> **And it was this breakthrough thinking that gave us hope that maybe we really had a solution**. So, I want you to imagine a setup. I want you to imagine a bunch of stratospheric internet balloons drifting with the winds. Now, that's a beautiful image, but these balloons will last a long time and will draft a long way, so maybe many times around the world. We want these balloons to go not just where the winds take them, we want these balloons to go where we want to provide the internet on the ground.

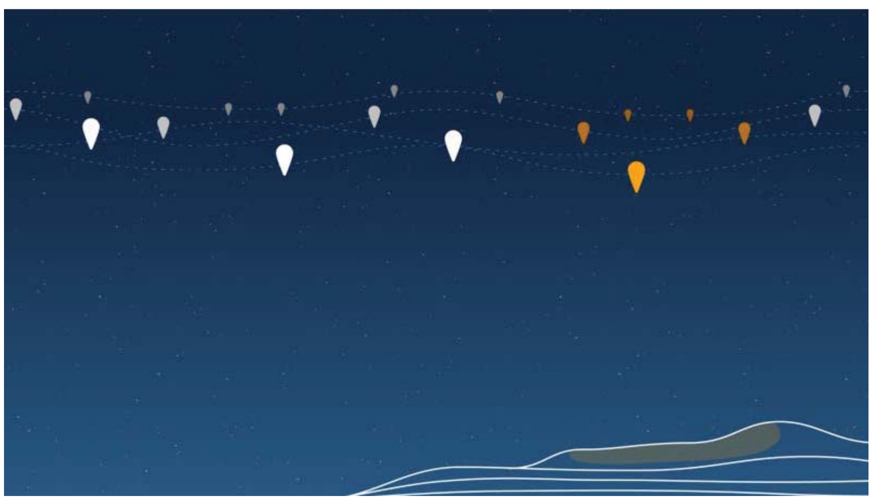
> **So, it turns out that the stratosphere is actually very stratified. Who would have thought, given the name? And what that means is the winds on different levels go different directions and different speeds. And so, if it were possible to go up and down in the stratosphere, you could catch a wind that would take you generally in the direction you wanted to go.**

www.youtube.com/watch?v=8tJWECskB9s

187. This was exactly what Google learned from Space Data years earlier.

188. Finally, Astro Teller has recently confirmed in his personal online blog that Google Loon "hovers" and works just like Space Data:

> **Improving balloon navigation**
>
> Project Loon's algorithms can now send small teams of balloons to form a cluster over a specific region where people need internet access. This is a shift from our original model for Loon in which we planned to create rings of balloons sailing around the globe, and balloons would take turns moving through a region to provide service.



With our original navigational models, rings of balloons sailed around the globe. As one balloon drifted out of range of a specific region, another would move in to take its place.

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Machine-learning-powered algorithms now enable us to send small teams of balloons to a specific region. The balloons dance on the winds in small loops to remain where needed.

***

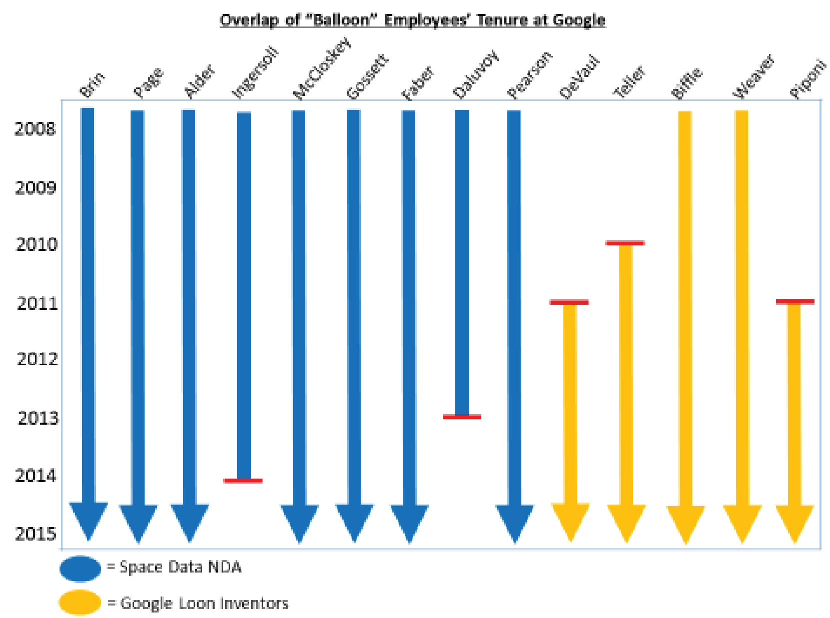
> **Back in 2011, we had a hunch that balloons flying freely on the winds could be controlled just enough to act like floating cell phone towers in the sky.** We'd pump air out of or into the balloon to make it lighter or heavier, and then move up or down to catch winds traveling in the direction we wanted to travel. When we ran our first sizable test of Project Loon in 2013, launching dozens of balloons from New Zealand to see if they'd circumnavigate the globe, we knew we had a lot to learn. We thought the balloons would act like leaves in a stream, flowing where the air currents went, and we figured our main task was to manage the balloons' paths just enough to keep them at a roughly equal distance from each other.

***

> By early 2016, the team was seeing a few balloons behave in a slightly weird way: lingering in an area rather than sailing away. In the weirdness, they saw opportunity. They asked themselves the once-impossible question: could our algorithms help the balloons to stay much closer to the location they were already in? In mid 2016, we started sending balloons from our launch site in Puerto Rico to hang out in Peruvian airspace—and they did, some for as long as three months. We repeated the experiments, and saw the same results: **we had figured out how to cluster balloons in teams, dancing in small loops on the stratospheric winds, over a particular region**.

*See* https://blog.x.company/how-project-loons-smart-software-learned-to-sail-the-winds-ec904e6d08c (emphasis added).

189. Google in no way used a clean room to develop Loon. Many of the Google engineers who had full access to Space Data information continued to work in the Google "Access" group, the very same small group the Google Loon "inventors" joined thereafter, as depicted below:




## I. Google Zealously Patents Every Aspect of Project Loon.

190. Beginning with a bevy of applications filed on January 9, 2012, Google assiduously patented every aspect of a constellation balloon network. Time and again, Google claimed as new and original Google inventions ideas disclosed to Google by Space Data or patented by Space Data **years** earlier.

191. For example, Google filed applications covering, and now claims, the following:

***A Balloon Constellation, Sailed in the Stratosphere***

192. Google claimed an airborne balloon constellation providing a communication mesh (internet coverage), where the horizontal placement of the balloons is a function of adjusting the balloon's altitude, up or down, to capture favorable wind patterns. *See* U.S. Patent 8,820,678 (DeVaul et al.). Google explains its ability to maintain a constellation array in the specification as follows:

> [I]n a high altitude balloon network, balloons [that] may generally be configured to operate at altitudes between 18 kilometers and 25 kilometers [59,000 ft and 82,000 ft].... This altitude range may be



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> advantageous for several reasons. **In particular, this layer of the stratosphere generally has relatively low wind speeds (e.g., winds between 5 and 20 mph) and relatively little turbulence. Further, while the winds between 18 kilometers and 25 kilometers** [59,000 ft and 82,000 ft] **may vary with latitude and by season, the variations can be modeled in a reasonably accurate manner.**

*Id.* at 4:43-53 (emphasis added). This was not Google's epiphany.

193. Google further described its ability to "sail" the balloons as follows:

> [A] desired horizontal movement of the target balloon may be achieved by adjusting the altitude of the target balloon…. To the extent that the target balloon is moving as a result of ambient winds, the motion of the target balloon can be adjusted by either increasing or decreasing its altitude. For example, altitude control may be used to achieve a desired horizontal movement of the target balloon by determining that the desired horizontal movement of the target balloon can be achieved by exposing the target balloon to ambient winds of particular velocity, determining that ambient winds of the particular velocity are likely to be available at a particular altitude… and adjusting the altitude of the target balloon to attain the particular attitude.

*Id.* at 20:47-66.

194. Google claimed these ideas generally in the '678 patent (thereafter captured by Space Data in interference proceeding, as set forth below in section J). **Google has now claimed various aspects of an airborne balloon constellation literally dozens of times over hundreds of claims.**

***<u>Using an Inner Bladder With Ventable Air as Ballast</u>***

195. As another example, Google claimed the idea of putting a bladder within a balloon, and using air in the bladder to serve as ballast. Since the balloon gas (hydrogen or helium) is lighter than air, air itself serves as ballast. To descend, one pumps more air into the inner bladder; to ascend, one evacuates air from the inner bladder. (This was disclosed to Google by Space Data at the February 15, 2008 meeting when discussing alternative ways to control altitude of balloons and Space Data discussed ballonets. When Ms. Ingersoll asked what a ballonet was, Space Data showed a book from 1927 with a chapter on ballonets as shown below. In fact, this is Dependent Claim 22 of Space Data's first patent, the '941 patent).

TABLE 2—SEAM WEIGHTS

| Type | Wt. Fabric oz. per sq. yd. | Wt. Seam lbs. per linear yd. |
|---|---|---|
| Ballonet Seam | 8.5 | .073 |
| Ballonet Shoe | 8.5 | .074 |
| Envelope Seam, Gas-tight, Circumferential | 13.4 | .0808 |
| Envelope Seam, Air-tight, Circumferential | 11.4 | .05214 |
| Envelope Seam, Gas-tight, Longitudinal | 13.4 | .129 |
| Envelope Seam, Air-tight, Longitudinal | 11.4 | .078 |

The width of the strips has been standardized to a maximum of 3 in.

The theoretical determination of the deformation of the envelope from which it is possible to determine the proper amount and location for tailoring, will not be dealt with here; it is set forth fully in Report No. 16 of the National Advisory Committee for Aeronautics (1917) by Haas and Dietzius as translated from the German by Professor Karl K. Darrow.

For the comparatively small nonrigid airships so far produced in this country, the proper amount of tailoring has been determined by one or more of the following methods: by observations on the form of the first airship of any new series upon which corrections may be based; by comparison of the bending moment curves of similar types of airships; or by water model tests showing the amount of deformation to be overcome.

### Ballonet

**Historical.** The ballonets of the first practical airship to be constructed in America, the Goodyear *F*, 77,000 cu. ft., sister ship of the Navy *B*, 84,000 cu. ft. airship, were ovoidal in form and were suspended from the top of the envelope by means of patches and ropes, one being located in the nose and the other one-fourth of the envelope length from the tail of the airship.



This type of ballonet proved impracticable for the following reasons: Excessive fabric weight; internal rigging which was difficult to install and inaccessible to inspection adjustment, and maintenance; inflation difficulties caused by gas pressure on folded fabric which produced excessive strains on the suspension, at times causing it to break away.

**Form.** The ovoidal form was superseded by the diaphragm. In this type the underside is formed by the envelope and the upper side by a diaphragm duplicating the portion of the envelope enclosed. The diaphragm is attached to the inside of the envelope along the "ballonet intersection line." The problem is to design the diaphragm so that on deflation of the ballonet, the diaphragm fabric will lie evenly upon the envelope beneath.

With the ballonet located in the *nose* of the envelope, the diaphragm is designed as a duplication of the envelope patterns beneath (see Figure 8).

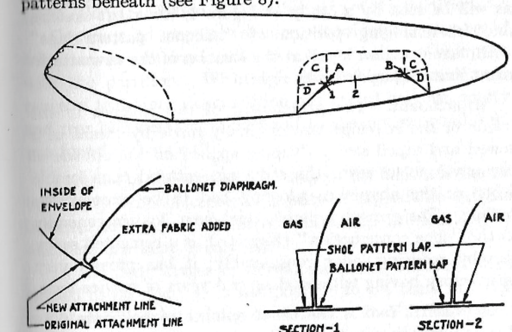


Figure 8. Ballonet Diaphragms and Attachment Details

## *On Balloon to Balloon Communications*

196. As another example, Google claimed using the predicted movements of balloons to keep the constellation together, so each balloon could communicate with the others (also disclosed by Space Data to Google). *See* U.S. Patent 9,306,668.

## *On the "Call Home" Recovery Station*

197. As a further example, Google claimed as a novel and innovative Google invention an "incentivized recovery" system. In plain English, Google would attach a label to the payload saying "reward: call" to ensure the recovery of the payload (also disclosed by Space Data to Google and on the side of many payloads Google photographed at Space Data's facility).

## *On Communicating Balloon to Balloon to Maintain Position*

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198. As another example, Google claimed as a novel and original Google invention the idea of the balloons in a constellation mesh communicating with one another to maintain position. *See* U.S. Patent 9,285,450 (an idea also disclosed by Space Data to Google).

***<u>On Flight Termination</u>***

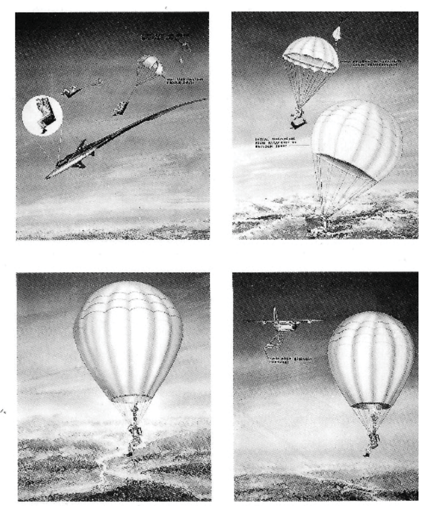
199. As another example, Google claimed as a novel and innovative Google invention the idea of using an Exacto blade on a rail to cut a hole in the top of a balloon, to vent gas, to cause the balloon to descend. *See* U.S. Patent 9,168,994 (also disclosed in concept by Space Data to Google).

200. As another example, Google claimed as a novel and original Google invention the idea of using a blade to cut the balloon in half, so the top half of the balloon would serve as a parachute. *See* 9,139,278. This is an old concept from the following illustrations, as shown below, from a coffee table book in Space Data's lobby the day of Google's tour and passed around to the visitors when discussing various lighter than air technologies.

initial free-balloon training for future pilots of navy blimps. As this involved expensive helium balloons, the first step was to determine how an existing envelope would perform with hot air rather than helium as the means of generating lift. A Minneapolis-based company called General Mills was given the contract, and their work resulted in the first modern hot-air balloon to take to the skies in more than a century (see box on page 82).

But the catalyst which succeeded in turning this first hesitant experiment into a new way of leisure flying for a huge worldwide market was due to a different research project for a different service. Both the US Air Force and the US Navy was concerned about the problems of rescuing downed pilots over hostile territory, where landing a plane or even a helicopter might be impossible. One idea, called the PASS, for Pilot Aerial Survival System, was based on providing each aircrew member with the materials to make a small hot-air balloon, capable of lifting one person to an altitude where they could be snatched to safety by a specially equipped slow-flying airplane or helicopter.

The target was to devise a reusable balloon which could lift a man to a height of 10,000 feet and continue flying for three hours. The contract was awarded to a company called Raven Industries, based at Sioux Falls in South Dakota, which had been started by former General Mills researchers, and the team based their work on finding new materials and techniques for making the principles first established by the Montgolfiers easier to use and more reliable in action.



**New materials, new ideas**

First and foremost, they needed a new material for the actual envelopes of the balloons. This had to be light, tough, and fire-resistant, with a close enough texture to prevent the air inside it from escaping. After an examination of modern synthetic materials, they selected a light, woven nylon cloth which was ideal for

ABOVE: *How the pilot-rescue hot-air balloon project was supposed to work, lifting the crew o a crippled airplane high enough to be picked up by a special rescue aircraft, instead of dropping to earth on a normal parachute*

***<u>On Controlling the Rate of Descent</u>***

201. As another example, Google claimed as an original and novel Google invention the idea of using a drag plate (that is, a piece of flat material) below the payload to slow the descent of a balloon, should the balloon fail. *See* U.S. Patent 9,096,301.



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***On a Cut Down Mechanism***

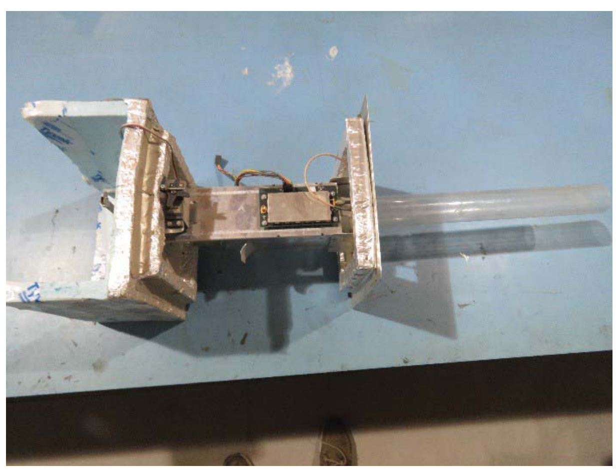
202. As another example, Google claimed as a novel and original Google invention the idea of using a "cut down" mechanism, to sever the payload from the balloon proper (also disclosed by Space Data to Google and used by Space Data in thousands of flights). *See* U.S. Patent 9,016,634.

***On Using a Fuel Cell for Energy***

203. As another example, Google claimed as a novel and original Google invention the idea of using a hydrogen fuel cell to generate electricity to run a heater to heat the balloon during nighttime hours (also disclosed by Space Data to Google). *See* U.S. Patent 9,290,258 (also disclosed by Space Data to Google).

***On Venting Gas through Straws***

204. As another example, Google claimed as an original and novel Google invention the idea of using "straws," (*i.e.* tubes) perforating the exterior of a balloon, where one end of the "straw" could be opened to vent gas to cause the balloon to descend (a concept also discussed between Space Data to Google). *See* U.S. Patent 9,211,942. Similar to an early Space Data payload on display during Google's tour of Space Data.



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***Why This Matters***

205. From January 9, 2012 forward, Google has filed at least 102 published Google Loon applications, many of which are now patents. Given that Google often files non-publication requests with its applications, as it did with every Loon application filed in January 2012 (the first filings), there may well be additional non-public Google Loon applications pending. Putting aside its systematic effort to capture as Google inventions ideas disclosed to Google by others, **in all of these applications, Google claimed as novel, innovative and patentable the Space Data ideas that Google now insists were fully in the public record long before Google filed its patents. If these ideas were public, as Google now claims in this litigation, Google could not have filed patents on these ideas. Google's own sworn declarations to the PTO contradict its advocacy position in this litigation.**

**J. The Interference: Google's Copycat Claims Now Belong to Space Data.**

206. The PTO has now recognized that Space Data is the senior rights holder on these foundational balloon constellation networking patents.

207. One of Google's first (January 9, 2012) patent filings related to "Relative Positioning of Balloons With Altitude Control and Wind Data." Google filed this application on January 9, 2012, along with several related applications. With each, Google filed a non-publication

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request, which kept the filings dark, even though significantly limiting Google's foreign rights. That is, Google lost something as its price for keeping these applications secret.

208. This application matured into U.S. Patent No. 8,820,678, which issued on September 2, 2014.

209. The specification begins by noting the increasing demand for "network infrastructure" given proliferating connected devices. This paragraph is common to most of Google's approximately 102 Loon patents and applications.

210. The specification then describes a constellation of balloons working together to create a "mesh" to provide a "data network…." The specification further describes **how** Google would pilot the balloon constellation:

> Example of embodiments help to provide a data network that includes a plurality of balloons; for example, a mesh network formed by high-altitude balloons deployed in the stratosphere. **Since winds in the stratosphere my affect the locations of the balloons in a differential manner, each balloon in an example network may be configured to change its horizontal position by adjusting its vertical position (i.e. altitude).** For example, by adjusting its altitude, a balloon may be able to find winds that will carry it horizontally (e.g., latitudinally and/or longitudinally) to a designed horizontal location.

U.S. Patent No. 8,820,678 at 2:63-3:6 (emphasis added).

211. The specification further describes an exemplary balloon, which consists of an outer envelope, an inner "bladder" which would use air as a ballast, a cut-down mechanism (to separate the payload form the balloon), several adjustable antennas, an electronics package, a battery and solar power source, and communications ability.

212. The '678 Google patent broadly claims using the winds to fly a balloon constellation to provide a balloon mesh network to provide a data communications system.

213. With this application, Google claimed as an original Google invention the preexisting Space Data balloon network, including the Space Data method of mapping winds in the stratosphere and flying the balloons accordingly.

214. On June 1, 2016, Space Data filed an interference with the Patent Trial and Appeal Board ("PTAB"). Space Data asserted that it was the senior rights holder, as Google had simply copied preexisting Space Data technology.

215. On June 26, 2016, Google's counsel conceded the interference, and told the Administrative Law judge that Google would not contest the interference. ("Google did not intend to contest priority in this case.").

216. On August 31, 2016, the Administrative Panel, Judge Moore presiding, ruled for Space Data. On December 22, 2016, the final Judgment was issued, and on February 22, 2017, after the statutory 63 day appeal period per 37 CFR 90.3 with no appeals filed, the judgment became final and nonappealable. The Google application and Google claims went back to the PTO to be assigned to Space Data.

217. On April 12, the PTO published a Notice of Allowance awarding the prior Google claims to Space Data. That patent will issue to Space Data in weeks.

218. **This prior Google '678 patent is fundamental to Google's Project Loon promiscuous patent filing strategy.** As Space Data has been adjudicated to be the senior rights owner on this parent application, it perforce is the senior rights holder on all children of the '678 patent and the many related patents.

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**K. <u>Google Uses Space Data's Trade Secrets as Well as its Patented Inventions</u>.**

219. As described above, Space Data made important refinements to the idea embodied in its '941 invention after that patent was issued.

220. After flying tens of thousands of flights, Space Data accumulated valuable, proprietary wind data that allowed Space Data to come to the conclusion that the optimum altitude for flying its constellation of balloons was in the approximately 60,000 to 80,000 foot "peaceful band." [redacted] was not known to the public in 2008 (as Space Data made this realization from its own proprietary wind data) and Space Data had not disclosed this finding in any of its patent applications or public statements.

221. This information about the "peaceful band," [redacted] and the wind data underlying this conclusion were all disclosed to Google under

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the NDA and Space Data is informed and believes Google flies its constellation in this band and spaces its Project Loon constellations this distance apart, precisely for the reasons Space Data identified in 2008 and based on the information received from Space Data.

222. Space Data also developed proprietary systems for monitoring its balloon constellation, controlling altitude with its hover algorithm, managing thermal heat regulation, and operating its system form the NOC, all of which were disclosed to Google in its visit in February 2008. With the team of executives and engineers and the aid of the camera Google brought to its visit, Google was able to capitalize on all of the trade secret information Space Data disclosed to it during this visit. Space Data is informed and believes that Google's Project Loon was developed based on the proprietary, trade secret information obtained from Space Data during the February 2008 visit and that such information proved to Google that a worldwide constellation of balloons providing network connectivity was feasible.

223. In addition to the technical information provided to Google, Space Data shared with Google detailed proprietary financial models which allowed Google to piece together the cost model and logistical processes involved in developing its own Project Loon. All of which is separate from any idea disclosed in any of Space Data's patents. Space Data is informed and believes that Google's Project Loon was developed based on the proprietary, trade secret information obtained from Space Data's financial data and modelling that showed a pathway to making a balloon-constellation communication system economically feasible.

224. Lastly, Space Data provided Google with confidential and proprietary "vision" slides in early 2008 which described, for the first time, the concept of a worldwide balloon-based network and gave Google detail on how to use a worldwide network, how to implement such a network and the advantages of such a network. This worldwide concept and the details on how to implement are not contained in any of Space Data's patents and were disclosed to Google only under the NDA for purposes of evaluating Space Data as an acquisition target. Then, suddenly, years later, this Space Data concept becomes "Google Loon."

## COUNT I

**(Infringement of United States Patent No. 6,628,941 Against all Defendants)**

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225. Space Data repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 to 224 above.

226. On September 30, 2003, United States Patent No. 6,628,941, entitled "Airborne Constellation of Communications Platforms and Method," (the "'941 Patent") was duly and legally issued. A true and correct copy of the '941 Patent is attached hereto as Exhibit B and incorporated herein by reference.

227. Gerald M. Knoblach and Eric A. Frische are the inventors of the '941 Patent. Space Data is the assignee and owner of all right, title, and interest in and to the '941 Patent.

228. The systems and methods practiced by Google's Project Loon infringes the '941 Patent. The following describes, at least in part, Project Loon, which "uses software algorithms to determine where its balloons need to go, then moves each one into a layer of wind blowing in the right direction. By moving with the wind, the balloons can be arranged to form one large communications network" (http://www.google.com/loon/how/).

229. The following describes, at least in part, Project Loon: "Each balloon can provide connectivity to a ground area about 80 km in diameter using a wireless communications technology called LTE. To use LTE, Project Loon partners with telecommunications companies to share cellular spectrum so that people will be able to access the Internet everywhere directly from their phones and other LTE-enabled devices. Balloons relay wireless traffic from cell phones and other devices back to the global Internet using high-speed links" (http://www.google.com/loon/how/).

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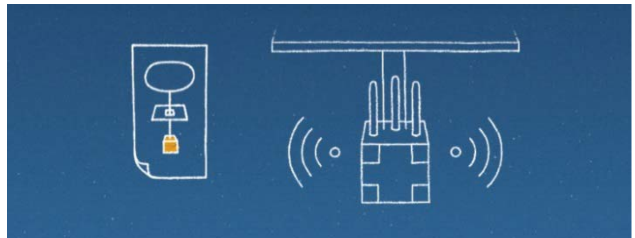
230. The Project Loon website describes a free-floating constellation communications system comprising a plurality of lighter-than-air platforms comprising at least a first platform and a second platform, as shown in the following images captured from the Project Loon website (http://www.google.com/loon/how/):

Project Loon balloons float in the stratosphere, twice as high as airplanes and the weather. They are carried around the Earth by winds and they can be steered by rising or descending to an altitude with winds moving in the desired direction. People connect to the balloon network using a special Internet antenna attached to their building. The signal bounces from balloon to balloon, then to the global Internet back on Earth.



A small box containing the balloon's electronic equipment hangs underneath the inflated envelope, like the basket that is carried by a hot air balloon. This box contains circuit boards that control the system, radio antennas to communicate with other balloons and with Internet antennas on the ground, and batteries to store solar power so the balloons can operate during the night.

Project Loon balloons travel around 20 km above the Earth's surface in the stratosphere. Winds in the stratosphere are generally steady and slow-moving at between 5 and 20 mph, and each layer of wind varies in direction and magnitude. Project Loon uses software algorithms to determine where its balloons need to go, then moves each one into a layer of wind blowing in the right direction. By moving with the wind, the balloons can be arranged to form one large communications network.

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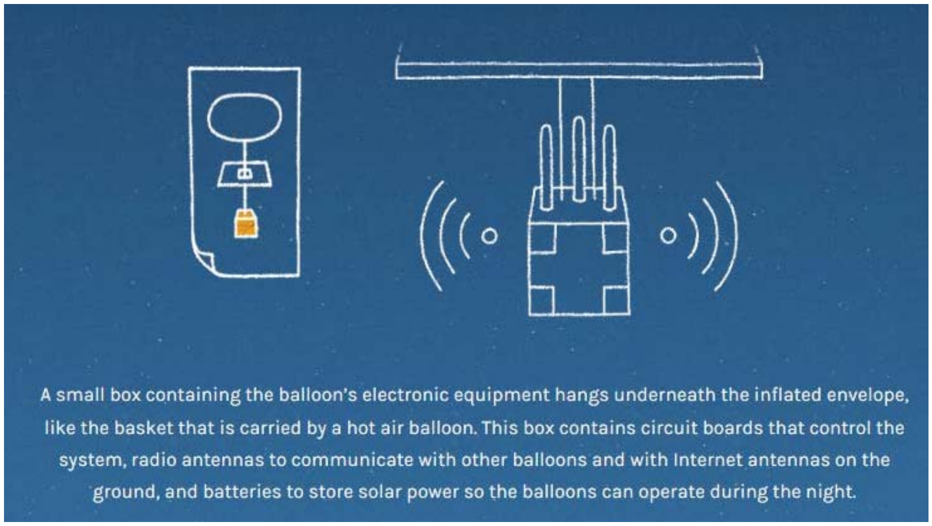
231. The Project Loon website describes a first and second platforms comprising a communications signal transceiver, as shown in the following images captured from the Project Loon web site (http://www.google.com/loon/how/):

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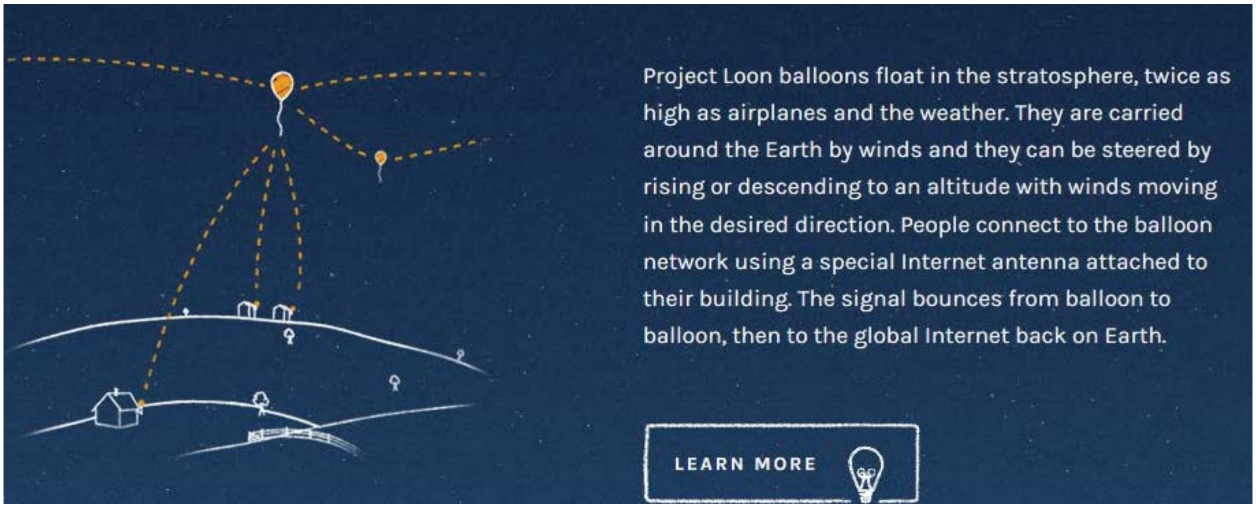
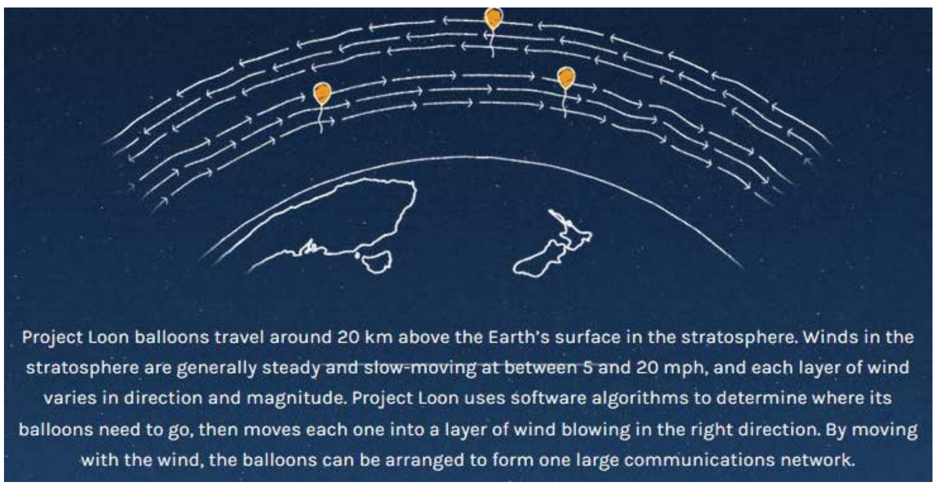
232. The Project Loon website describes a free floating platform without any longitudinal and latitudinal position control, as shown in the following images captured from the Project Loon website (http://www.google.com/loon/how/):

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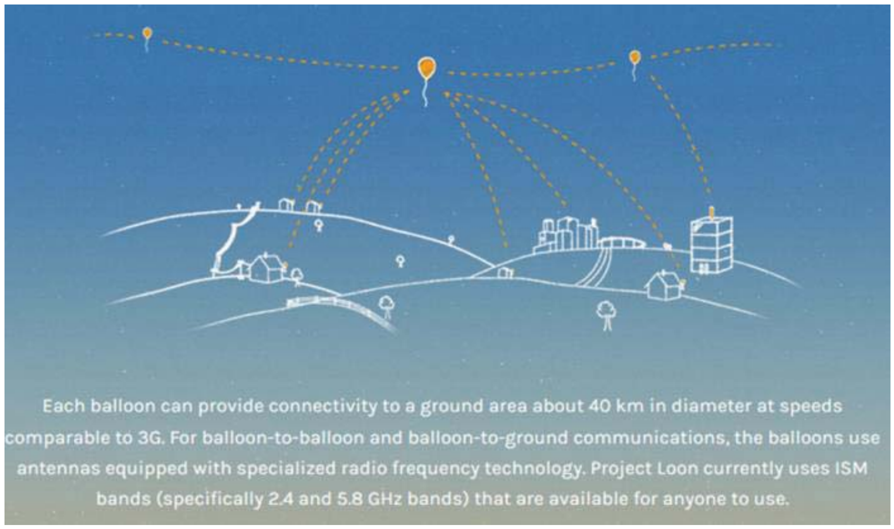
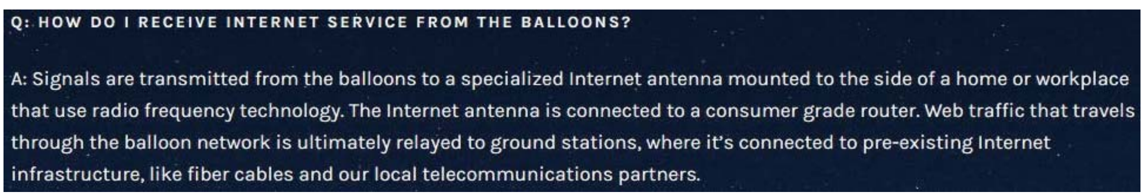
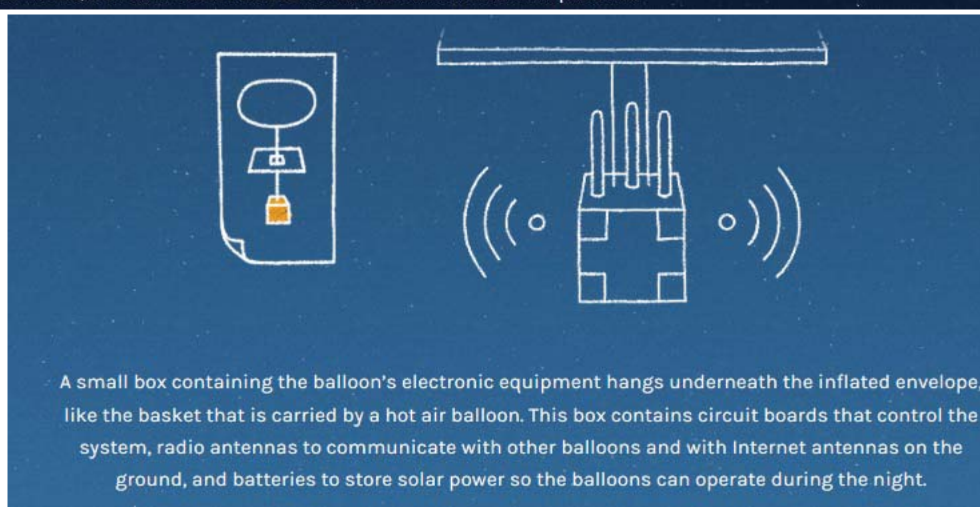
233. The Project Loon website describes a plurality of communications devices within a contiguous geographic area, at least one of said communications devices having communications capability with communications signal transceivers, as shown in the following images captured from the Project Loon website ([http://www.google.com/loon/how/](http://www.google.com/loon/how/)):





Q: HOW DO I RECEIVE INTERNET SERVICE FROM THE BALLOONS?

A: Signals are transmitted from the balloons to a specialized Internet antenna mounted to the side of a home or workplace that use radio frequency technology. The Internet antenna is connected to a consumer grade router. Web traffic that travels through the balloon network is ultimately relayed to ground stations, where it's connected to pre-existing Internet infrastructure, like fiber cables and our local telecommunications partners.



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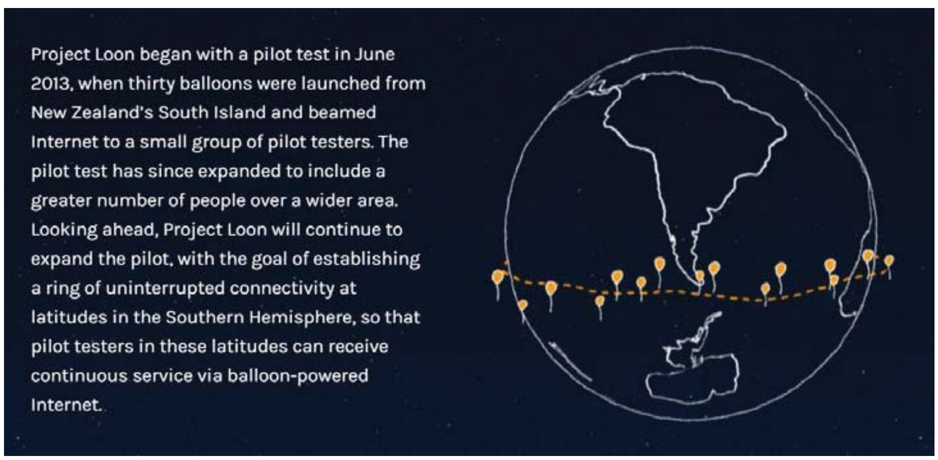
234. The Project Loon website shows communications devices capable of handing off communication with one platform to another platform as the first platform moves out of a communication range of said at least one of the communications devices, as shown in the following images and video narratives captured from the Google Project Loon website (http://www.google.com/loon/how/ and https://www.youtube.com/watch?v=HOndhtfIXSY ):

"… so another balloon is coming just at the right time to take the place of one that left." Project Lead, Mike Cassidy, https://www.youtube.com/watch?v=HOndhtfIXSY.

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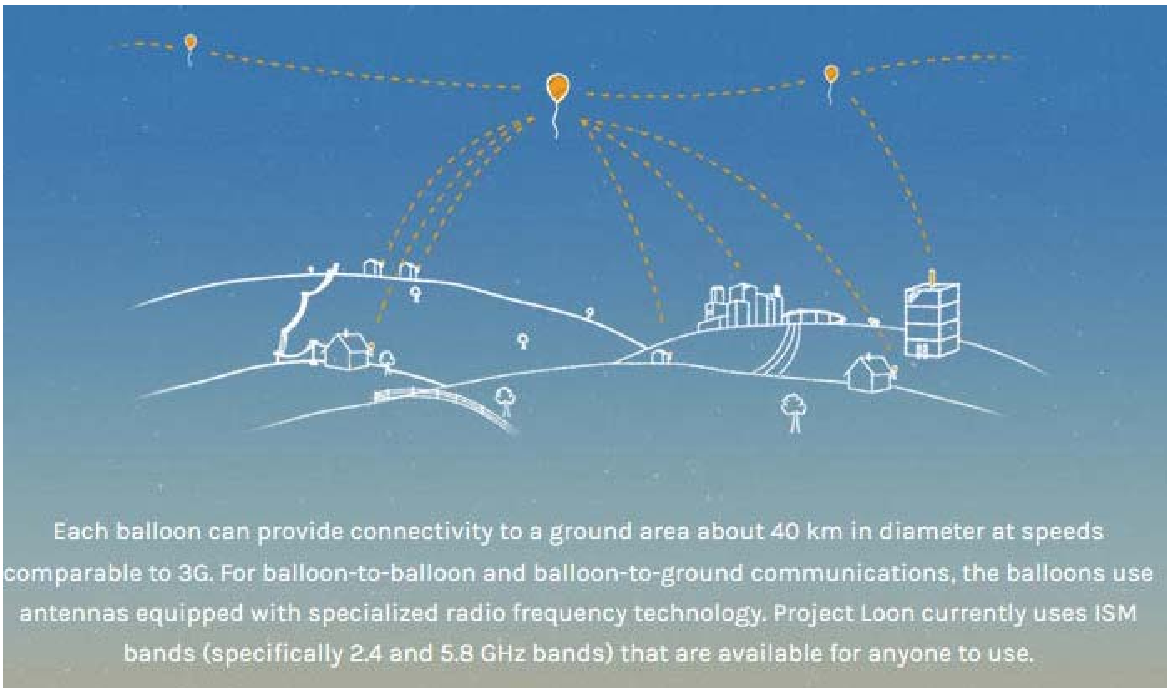
235. The Project Loon website shows a free floating constellation communications system that provides a line-of-sight coverage of wireless data to a population on a contiguous landmass, as shown in the following information captured from the Project Loon website (http://www.google.com/loon/how/):

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236. The Project Loon website shows a plurality of lighter-than-air platforms operating in a range of 60,000 to 140,000 feet, as shown in the following information captured from the Project Loon website (http://www.google.com/loon/how/):

**Q: WHAT ARE PROJECT LOON BALLOONS?**

A: Project Loon is a global network of high altitude balloons. The balloons ascend like weather balloons until they reach the stratosphere, where they drift above 18 km (60,000 ft), safely above the altitudes used for aviation. Unlike weather balloons, Loon balloons are superpressure, which enable them to stay aloft for 100+ days at a time. This is far longer than typical weather balloons, which last for a matter of hours. Loon balloons are also unique in that they are steerable and entirely solar powered.

Project Loon balloons travel around 20 km above the Earth's surface in the stratosphere. Winds in the stratosphere are generally steady and slow-moving at between 5 and 20 mph, and each layer of wind varies in direction and magnitude. Project Loon uses software algorithms to determine where its balloons need to go, then moves each one into a layer of wind blowing in the right direction. By moving with the wind, the balloons can be arranged to form one large communications network.

**Q: HOW HIGH DO THE BALLOONS FLY?**

A: We are flying in the stratosphere well above commercial air traffic and weather events, at around 18-27 km or 60,000 - 90,000 feet.

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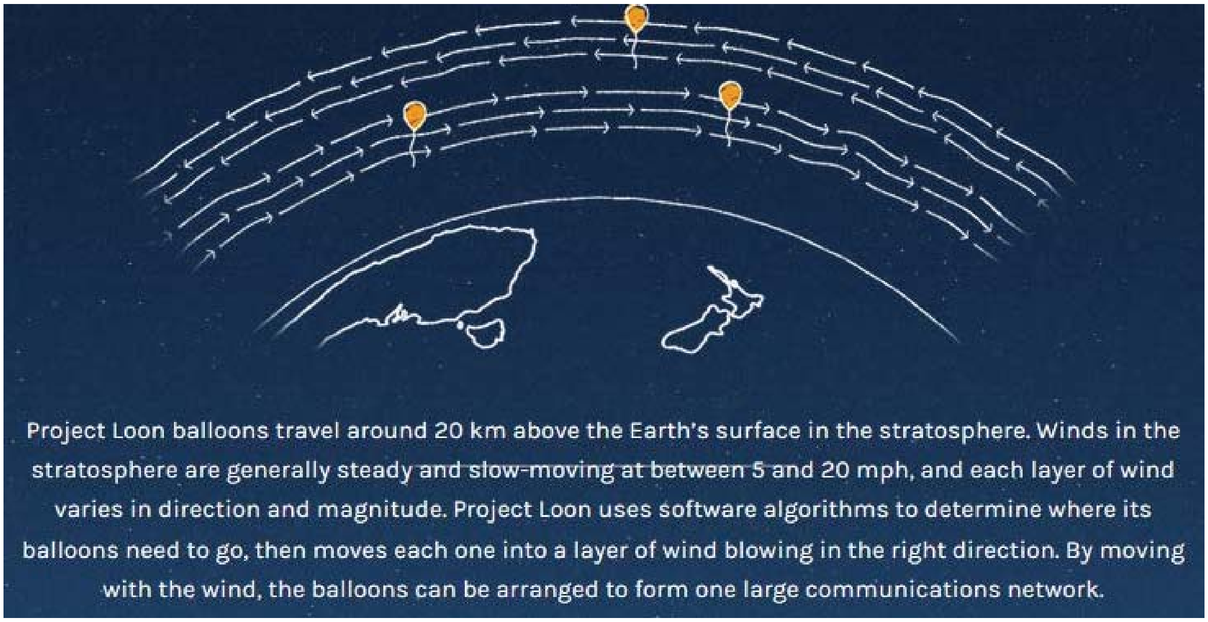
237. The Project Loon website describes that there is substantially a relative distance between the launched plurality of lighter-than-air platforms, as shown in the following images captured from the Project Loon website (http://www.google.com/loon/how/):




238. Defendants infringe claims of the ‘941 Patent. Defendants, without authority, make, use, offer to sell, and/or sell instrumentalities that practice systems and methods covered by claims of the ‘941 Patent. Google's Loon instrumentalities meet all of the elements of claims of the ‘941 Patent, including, as further detailed in paragraphs 230 to 237 above, all the elements of the ‘941 Patent, Claim 1. Defendants have been, and are currently, directly infringing at least claim 1 of the ’941 Patent in violation of 35 U.S.C. § 271(a), literally or under the doctrine of equivalents, by its Google Loon instrumentalities, that practice the system disclosed in the ’941 Patent.

239. While Defendants have been on notice of the ’941 Patent since at least September 2007, Defendants started to, and continue to, make, use, offer to sell, and/or sell instrumentalities that infringe the ’941 Patent despite knowledge that their actions constitute infringement of a valid patent. In September 2007, Space Data sent Defendants information about Space Data and its technology which noted Space Data's ownership of patents. On February 15, 2008, executives of Defendants visited Space Data and launched a component of a Space Data system that practices the ’941 Patent and which bore the ’941 Patent marking. That same day, Defendants were exposed to

further components of, and information on, a Space Data system that practices the ’941 Patent. More, Defendants disclosed the ’941 Patent in an information disclosure statement they filed in February 2012, as part of the prosecution of its ’678 Patent (many of the ’678 Patent claims were assigned to Space Data as part of an interference proceeding). Defendants had knowledge of the ’941 Patent and Space Data’s technology that embodies it prior to when Defendants purport to have started work on their infringing instrumentalities (2011), and prior to Defendants’ public launch of its instrumentalities (2013). Nevertheless, Defendants proceeded with their infringing instrumentalities despite their knowledge (and an objectively high likelihood) that their acts would infringe the ’941 Patent. Defendants’ infringement of the ’941 Patent is willful, intentional and done in subjective bad faith.

240. As a result of Defendants’ direct infringement, Space Data has been and continues to be damaged and irreparably injured, including without limitation, the loss of sales and profits it would have earned but for Defendants’ actions, and damage to Space Data’s reputation among potential and existing customers, business partners, investors, and in the industry in general.

241. Defendants will continue to irreparably harm Space Data unless enjoined. Space Data faces real, substantial and irreparable damage and injury of a continuing nature from infringement for which Space Data has no adequate remedy at law.

**COUNT II**

**(Misappropriation of Trade Secrets Pursuant to 18 U.S.C. §§ 1836(b) and 1837 Against All Defendants)**

242. Space Data repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 to 224 above.

243. Space Data’s proprietary confidential technical and financial information disclosed to Defendants, as further described above, *see, e.g.*, ¶¶85, 90, 92, 94-95, 110-129, 131-133 & 136, constitutes trade secrets under 18 U.S.C. § 1839(3). These trade secrets were disclosed under the NDA between Space Data and Defendants. These trade secrets derive independent economic value from not being generally known to, and not being readily ascertainable through proper means by, another person who can obtain economic value from their disclosure or use. Throughout its

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corporate history, Space Data has undertaken reasonable measures to keep secret its proprietary confidential information. Employees all sign secrecy agreements, the Space Data facilities are security card keyed, all visitors sign in on a mandatory visitor log, and no third party prospective partner was shown proprietary confidential information absent signing a non-disclosure agreement.

244. Space Data's asserted trade secrets are not disclosed by Space Data's asserted patents. For example, and as further detailed in paragraphs 43, 112-117, and 220 above, Space Data's proprietary confidential analysis of the micro-wind structure of the 60,000 to 140,000 foot range that shows a "peaceful band" at approximately 60,000 to 80,000 feet, [redacted], was not disclosed in the '941 Patent. As a further example, the patents-in-suit clearly make no detailed financial disclosures with respect to the cost and logistical process of operating a balloon constellation. Proprietary confidential financial information disclosed by Space Data to Defendants under the NDA makes such detailed cost and logistical process disclosures.

245. Defendants misappropriated Space Data's trade secrets. For example, Defendants used Space Data trade secrets, without express or implied consent, by using Space Data trade secrets in connection with its assessment of whether to pursue its Project Loon business and in its Project Loon business thereafter, as further described above. *See, e.g.*, paragraphs 143 and 220-224. Defendants knew or had reason to know that they could not use Space Data trade secrets in this way, as this use vastly exceeds the use permitted under the NDA, which was limited to use in connection with "discussions and negotiations concerning a proposed acquisition of the shares or assets of [Space Data]." Defendants also disclosed Space Data trade secrets, without express or implied consent. Defendants knew or had reason to know at the time of Defendants' disclosures that Defendants had a duty to maintain the secrecy of Space Data's trade secrets, as Defendants' disclosures exceed those permitted under the NDA, which obligated Defendants to hold Space Data's trade secrets in "confidence" and not to disclose them to "any person outside its organization." Defendants also knowingly acquired Space Data trade secrets by improper means, including misrepresentation and breach of a duty to maintain secrecy. Defendants' use, disclosure

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and acquisition of Space Data's trade secrets constitutes misappropriation under 18 U.S.C. § 1836(b), 1837 & 1839(5-6).

246. Space Data's trade secrets misappropriated by Defendants relate to products and/or services used in, or intended for use in, interstate or foreign commerce. For example, Space Data trade secrets misappropriated by Defendants relate to Space Data's constellation of stratospheric floating balloons for communications. Space Data uses its balloon constellation in interstate commerce. By 2004 Space Data had deployed a number of balloons covering four states, and by 2007 Space Data had a working balloon constellation covering vast swaths of the Southwestern United States. Space Data's technology has also been deployed abroad, including in Iraq.

247. Space Data suffered damage as a direct and proximate result of Defendants' misappropriation of Space Data's trade secrets. The damage suffered by Space Data includes, without limitation, the loss of sales and profits it would have earned but for Defendants' actions, and damages to Space Data's reputation among potential and existing customers, business partners, investors, and in the industry in general. Defendants have also been unjustly enriched by their misappropriation of Space Data's trade secrets.

248. Defendants' misappropriation and misconduct was willful and malicious. Defendants intentionally breached the use and disclosure limitations imposed by the NDA, and deliberately exercised ownership over Space Data's trade secrets, in a conscious effort to harm Space Data's competitive position and to gain a competitive advantage over Space Data, in reckless disregard for Space Data's rights in its trade secrets.

249. Defendants' use of Space Data trade secrets, without express or implied consent, in connection with Defendants' Project Loon business is ongoing. Defendants' continuing misuse and/or disclosure of Space Data's trade secrets caused and continues to cause irreparable harm to Space Data for which Space Data has no adequate remedy at law. An injunction prohibiting Defendants from further use and/or disclosure of Space Data's trade secrets is necessary to provide Space Data complete relief.

**COUNT III**

**(Misappropriation of Trade Secret Pursuant to California Civil Code § 3426, *et seq.* Against**

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**All Defendants)**

250. Space Data repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 to 224 above.

251. Space Data's proprietary confidential technical and financial information disclosed to Defendants, as further described above, *see, e.g.*, ¶¶85, 90, 92, 94-95, 110-129, 131-133 & 136, constitutes trade secrets under Cal. Civ. Code § 3426.1(d). These trade secrets were disclosed under the NDA between Space Data and Defendants. These trade secrets derive independent economic value from not being generally known to the public, or to others who can obtain economic value from their disclosure. Throughout its corporate history, Space Data has undertaken reasonable efforts to maintain the secrecy of its proprietary confidential information. Employees all sign secrecy agreements, the Space Data facilities are security card keyed, all visitors sign in on a mandatory visitor log, and no third party prospective partner was shown proprietary confidential information absent signing a non-disclosure agreement.

252. Space Data's asserted trade secrets are not disclosed by Space Data's asserted patents. For example, and as further detailed in paragraphs 43, 112-117, and 220 above, Space Data's proprietary confidential analysis of the micro-wind structure of the 60,000 to 140,000 foot range that shows a "peaceful band" at approximately 60,000 to 80,000 feet, [redacted], was not disclosed in the '941 Patent. As a further example, the patents-in-suit clearly make no detailed financial disclosures with respect to the cost and logistical process of operating a balloon constellation. Proprietary confidential financial information disclosed by Space Data to Defendants under the NDA, makes such detailed cost and logistical process disclosures.

253. Defendants misappropriated Space Data's trade secrets. For example, Defendants used Space Data trade secrets, without express or implied consent, by using Space Data's trade secrets in connection with its assessment of whether to pursue its Project Loon business and in its Project Loon business thereafter, as further described above. *See, e.g.*, paragraphs 143 and 220-224. Defendants knew or had reason to know that they could not use Space Data's trade secrets in

this way, as this use vastly exceeds the use permitted under the NDA, which was limited to use in connection with "discussions and negotiations concerning a proposed acquisition of the shares or assets of [Space Data]." *See*, Ex. A. Defendants also disclosed Space Data trade secrets, without express or implied consent. Defendants knew or had reason to know at the time of Defendants' disclosures that Defendants had a duty to maintain the secrecy of Space Data's trade secrets, as Defendants' disclosures exceed those permitted under the NDA, which obligated Defendants to hold Space Data's trade secrets in "confidence" and not to disclose them to "any person outside its organization." Defendants also knowingly acquired Space Data trade secrets by improper means, including misrepresentation and breach of a duty to maintain secrecy. Defendants' use, disclosure and acquisition of Space Data's trade secrets constitutes misappropriation under Cal. Civ. Code § 3426.1(b).

254. Space Data suffered damage as a direct and proximate result of Defendants' misappropriation of Space Data's trade secrets. The damage suffered by Space Data includes, without limitation, the loss of sales and profits it would have earned but for Defendants' actions, and damages to Space Data's reputation among potential and existing customers, business partners, investors, and in the industry in general. Defendants have also been unjustly enriched by their misappropriation of Space Data's trade secrets.

255. Defendants' misappropriation and misconduct was willful and malicious. Defendants intentionally breached the use and disclosure limitations imposed by the NDA, and deliberately exercised ownership over Space Data's trade secrets, in a conscious effort to harm Space Data's competitive position and to gain a competitive advantage over Space Data, in reckless disregard for Space Data's rights in its trade secrets.

256. Defendants' continuing misuse and/or disclosure of Space Data's trade secrets caused and continues to cause irreparable harm to Space Data for which Space Data has no adequate remedy at law. An injunction prohibiting Defendants from further use and/or disclosure of Space Data's trade secrets is necessary to provide Space Data complete relief.

**COUNT IV**

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**(Breach of Written Contract Against All Defendants)**

257. Space Data repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 to 224 above.

258. Defendants and Space Data entered into a "Mutual Confidentiality and Nondisclosure Agreement," effective December 1, 2007 (the "NDA"). The NDA is attached hereto as Exhibit A, and incorporated herein by reference.

259. Space Data performed or substantially performed under the NDA and/or any non-performance by Space Data was excused.

260. Under the NDA Space Data disclosed "Confidential Information" to Defendants, including Space Data technical and financial information, know-how and trade secrets. The Space Data Confidential Information disclosed under the NDA to Defendants, includes, but is not limited to, information shared with Defendants during Defendants' February 2008 visit to Space Data's Chandler, Arizona facility.

261. Defendants breached the NDA by, among other things: (1) using Space Data Confidential Information to assess whether the Defendants should undertake their Google Loon Project business; (2) using Space Data Confidential Information in implementations of their Google Loon Project technology; (3) disclosing Space Data Confidential Information; and (4) exercising ownership over Space Data Confidential Information. Defendants' use, disclosure and exercise of ownership over Space Data Confidential Information violates at least Sections 4 and 8 of the NDA. *See* Ex. A. Examples of specific conduct of Defendants that violated the NDA are further described in paragraphs 143 and 220-224 above.

262. Pursuant to the NDA, Defendants were obligated to "hold in confidence" and "not [to] disclose to any person outside its organization" any Space Data Confidential Information. Defendants and its personnel were permitted to use Space Data Confidential Information "only for the purposes" of "discussions and negotiations concerning a proposed acquisition of shares or assets of" Space Data. Defendants' use of Space Data Confidential Information, including certain information identified herein as Space Data's trade secrets, in connection with Defendants' own constellation of stratospheric floating balloons for communication, opposed to solely in relation to

Defendants' assessment of whether to purchase Space Data, was a violation of Section 4 of the NDA.

263. Pursuant to Section 8 of the NDA, "[n]o party acquire[d] any intellectual property rights under [the NDA] (including, but not limited to, patent, copyright, and trademark rights) except the limited rights necessary to carry out the purposes set forth in [the NDA]." *See* Ex. A. Defendants' use of Space Data Confidential Information in connection with Defendants' own constellation of stratospheric floating balloons for communication, is contrary to, and in violation of Section 8, as the NDA expressly states that Defendants shall not acquire any intellectual property rights in Space Data's Confidential Information.

264. Space Data suffered damage as a direct and proximate result of Defendants' breaches of the NDA. The damage suffered by Space Data includes, without limitation, the loss of sales and profits it would have earned but for Defendants' actions, and damages to Space Data's reputation among potential and existing customers, business partners, investors, and in the industry in general. Defendants have also been unjustly enriched by their use of Space Data's Confidential Information in violation of the NDA.

265. Defendants will continue to breach the NDA as described above unless enjoined from doing so by this Court. Space Data faces real, substantial and irreparable injury of a continuing nature owing to Defendants' continuing breaches of the NDA for which Space Data has no adequate remedy at law.

**COUNT V**

**(Infringement of United States Patent No. 9,632,503 Against all Defendants)**

266. Space Data repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 to 224 above.

267. On April 25, 2017, United States Patent No. 9,632,503, entitled "Systems and Applications of Lighter-Than-Air (LTA) Platforms," (the "'503 Patent") was duly and legally issued. A true and correct copy of the '503 Patent is attached hereto as Exhibit E and incorporated herein by reference.

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268. Gerald M. Knoblach, Eric A. Frische and Bruce Alan Barkley are the inventors of the ’503 Patent. Space Data is the assignee and owner of all right, title, and interest in and to the ’503 Patent.

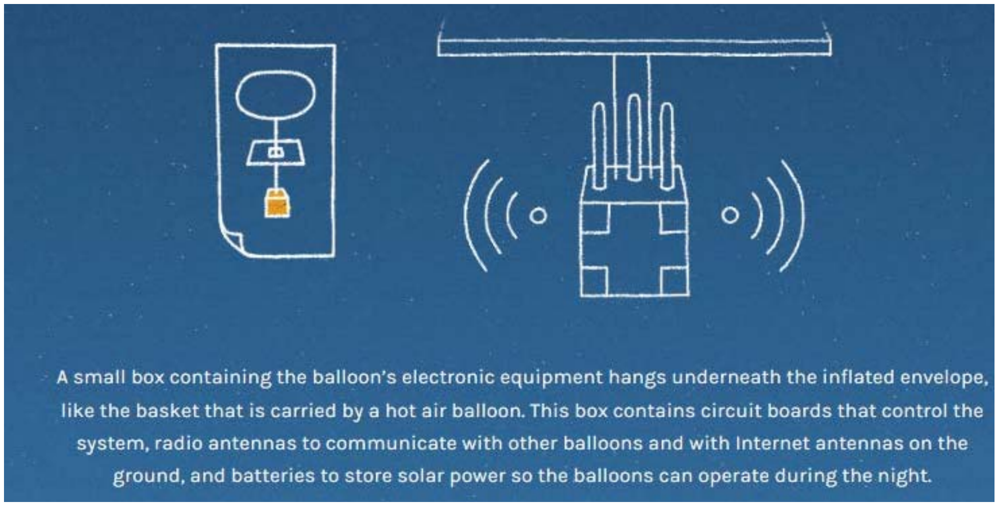
269. The systems and methods practiced by Google’s Project Loon infringes the ’503 Patent.

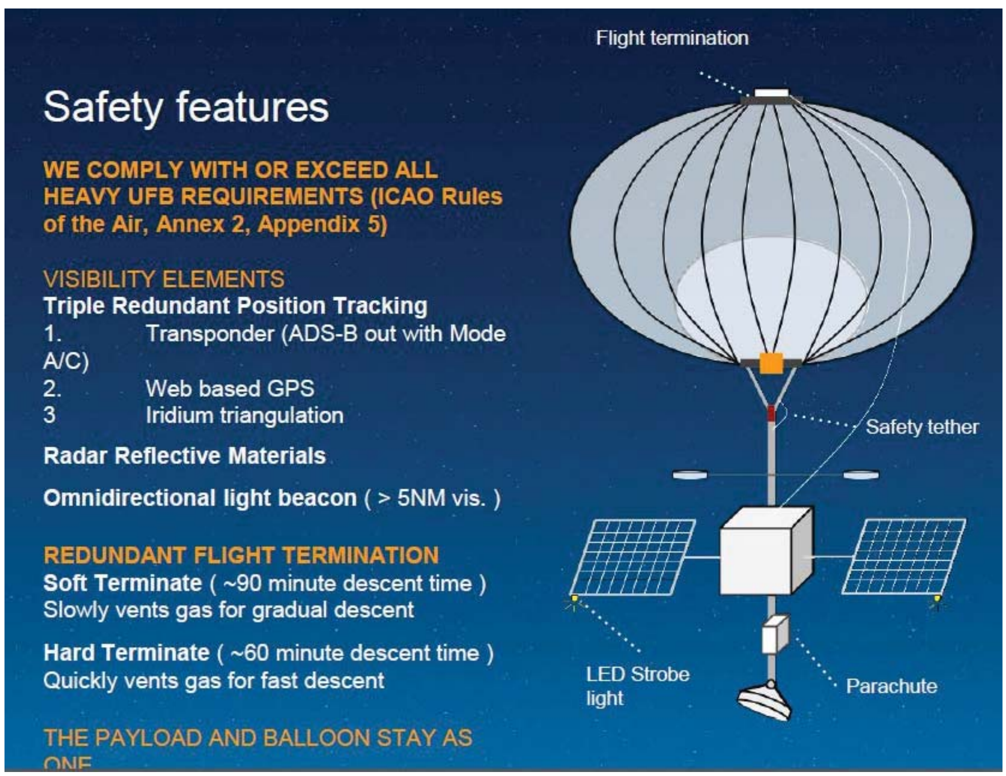
270. The Google Project Loon website shows that it has deployed a system comprising a plurality of airborne platforms, each airborne platform comprising an unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

Project Loon balloons float in the stratosphere, twice as high as airplanes and the weather. They are carried around the Earth by winds and they can be steered by rising or descending to an altitude with winds moving in the desired direction. People connect to the balloon network using a special Internet antenna attached to their building. The signal bounces from balloon to balloon, then to the global Internet back on Earth.

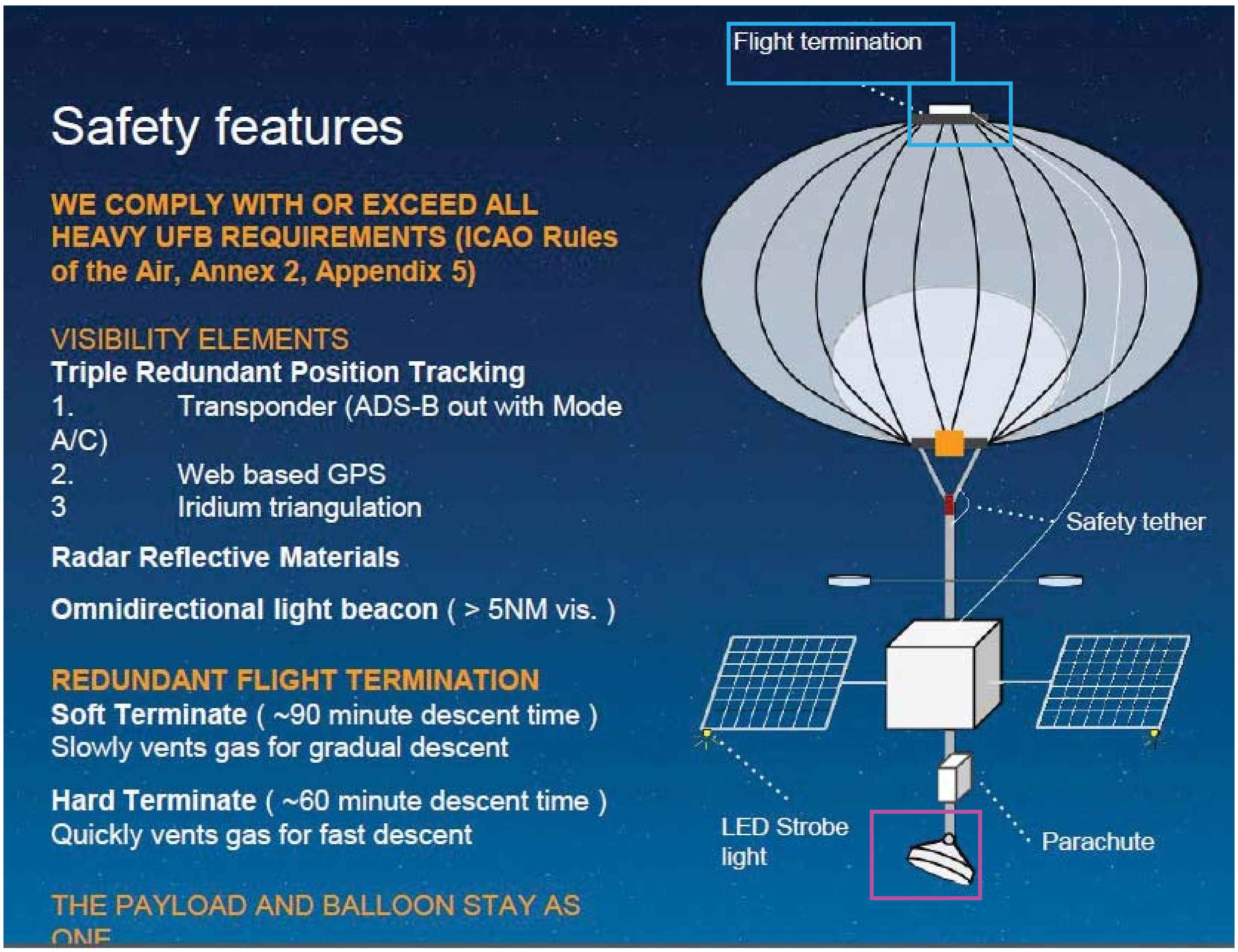
Project Loon balloons travel around 20 km above the Earth’s surface in the stratosphere. Winds in the stratosphere are generally steady and slow-moving at between 5 and 20 mph, and each layer of wind varies in direction and magnitude. Project Loon uses software algorithms to determine where its balloons need to go, then moves each one into a layer of wind blowing in the right direction. By moving with the wind, the balloons can be arranged to form one large communications network.

271. The Google Project Loon website shows that it has deployed a system with a payload that is separate from the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):



272. The Google Project Loon website shows that it has deployed a system with a transceiver, and first and second flight termination devices, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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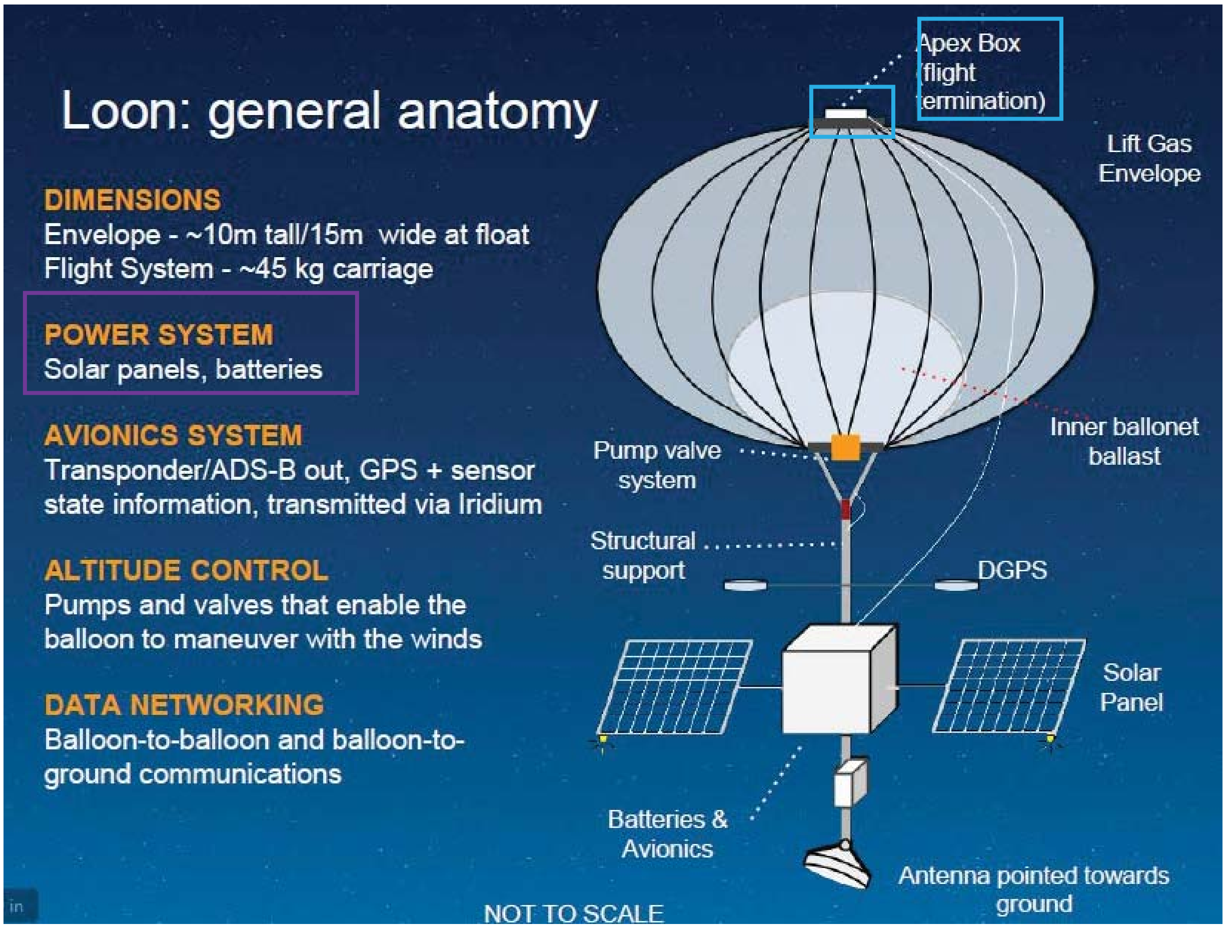
273. The Google Project Loon website shows that it has deployed a system with at least two separate power sources for the first and second flight termination devices, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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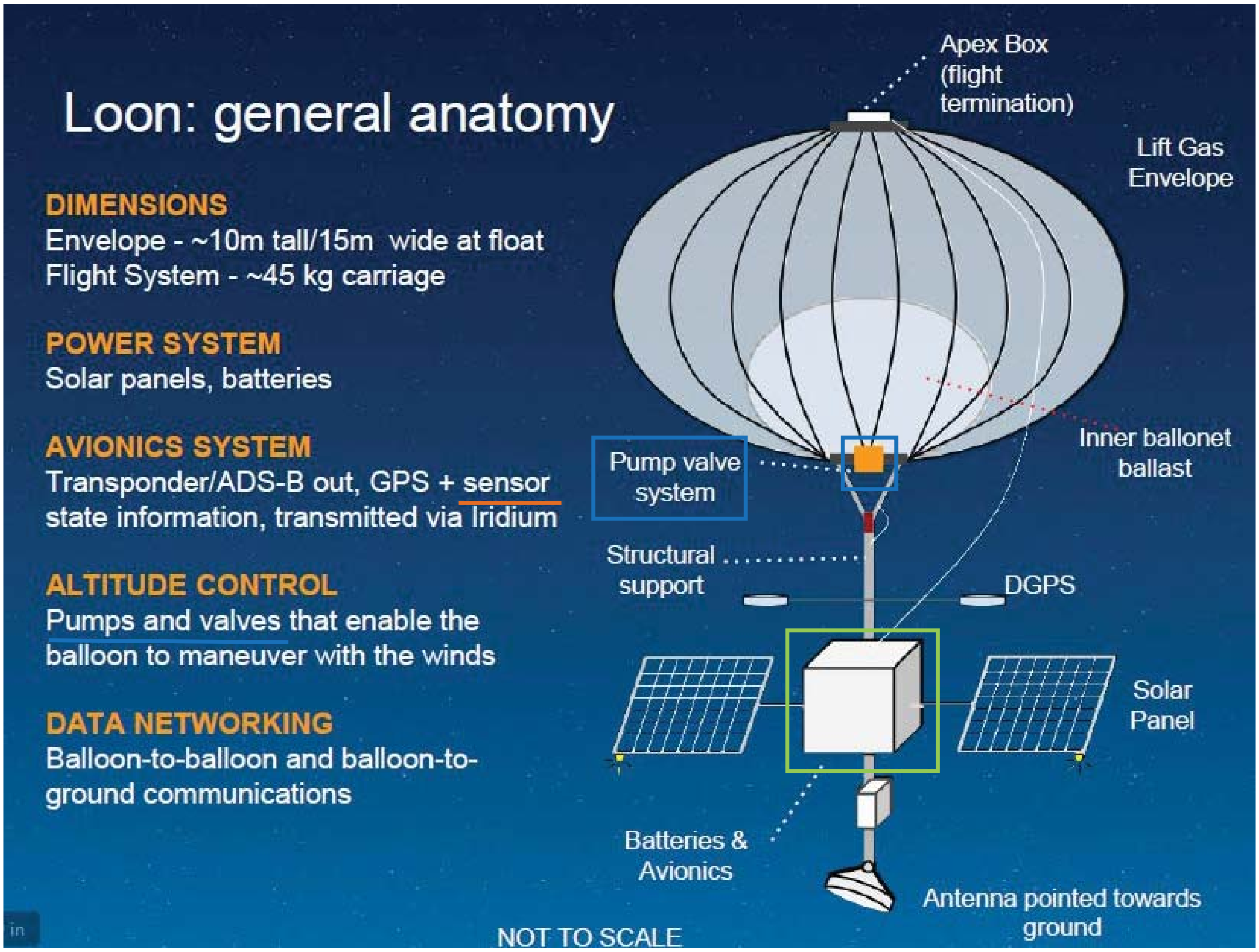
274. The Google Project Loon website shows that it has deployed a system with a sensor, a processor, a pump, and a valve, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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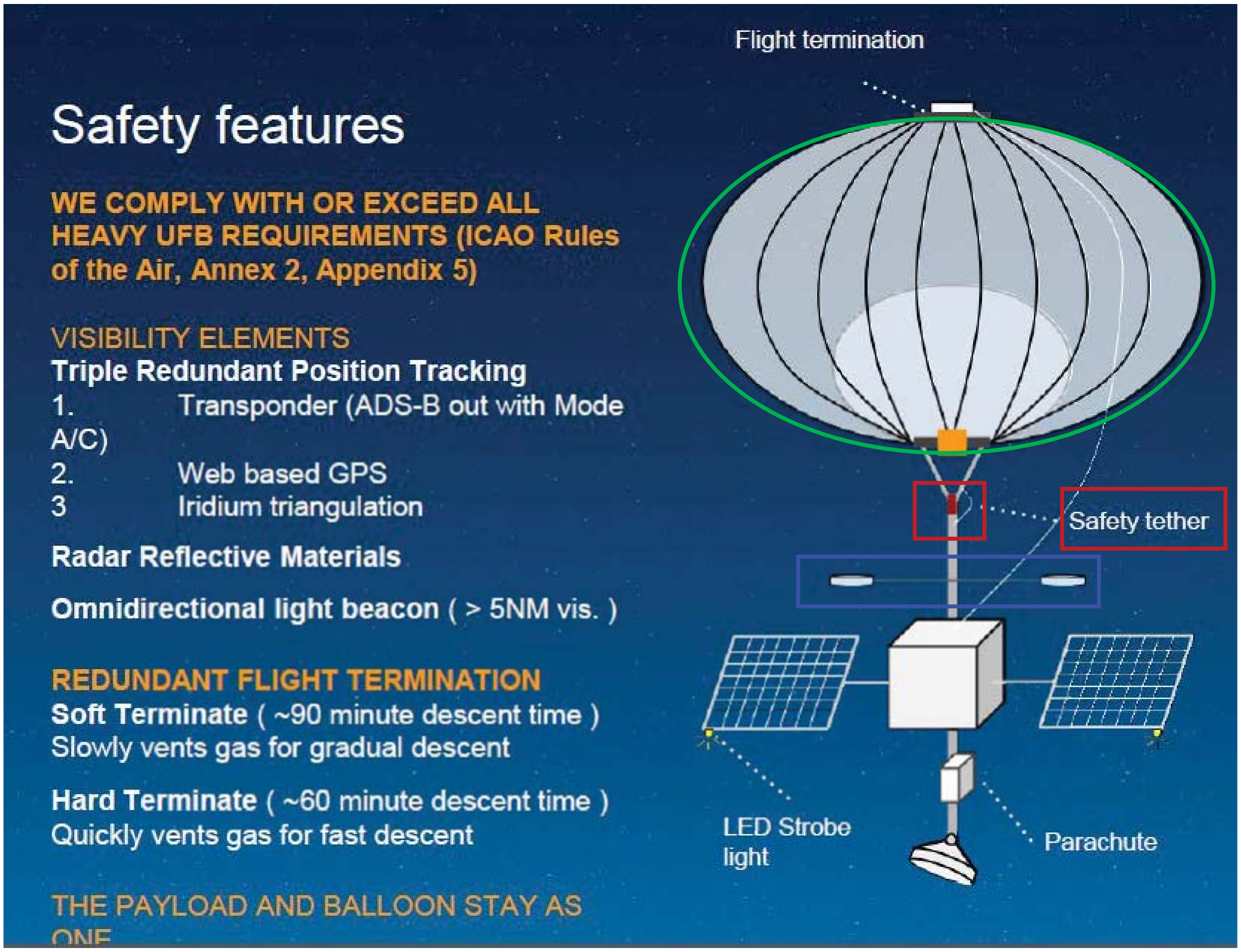
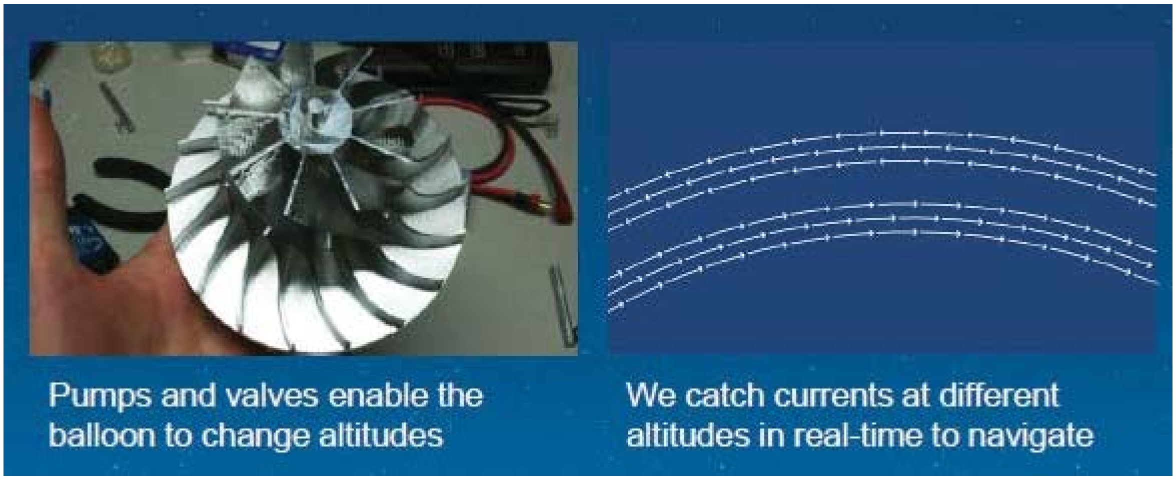
275. The Google Project Loon website shows that it has deployed a system with a tether that when broken separates the unmanned balloon and the payload, as shown in the following image captured from the Google Project Loon website (http://www.google.com/loon/how/):




276. The Google Project Loon website shows that it has deployed a system wherein the pump and the valve are configured to change an altitude of the airborne platform, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):




**ALTITUDE CONTROL**
Pumps and valves that enable the balloon to maneuver with the winds

277. The Google Project Loon website shows that it has deployed a system wherein the sensor comprises a pressure sensor, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

**AVIONICS SYSTEM**
Transponder/ADS-B out, GPS + sensor state information, transmitted via Iridium

**Estimated Life Expectancy** : Through multiple sensors, our flight systems constantly check indicators of balloon life (e.g., temperature and pressure).

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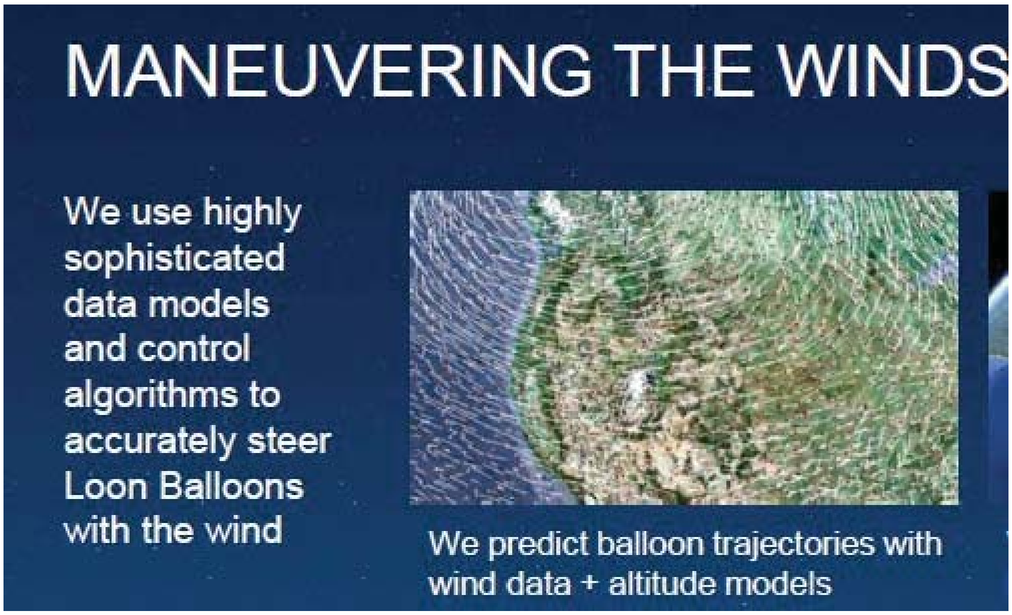
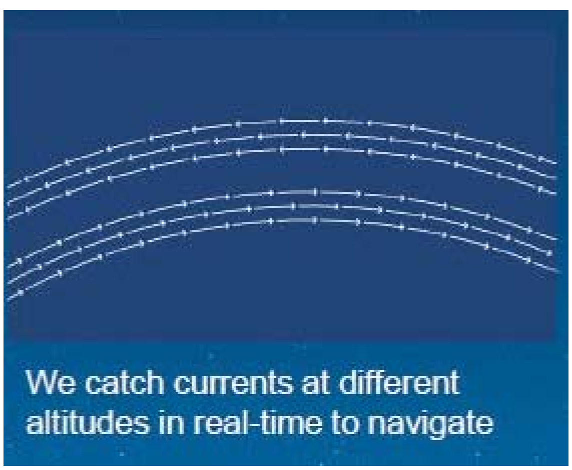
278. The Google Project Loon website shows that it has deployed a system wherein, in operation, the unmanned balloon substantially drifts along with the wind currents, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):





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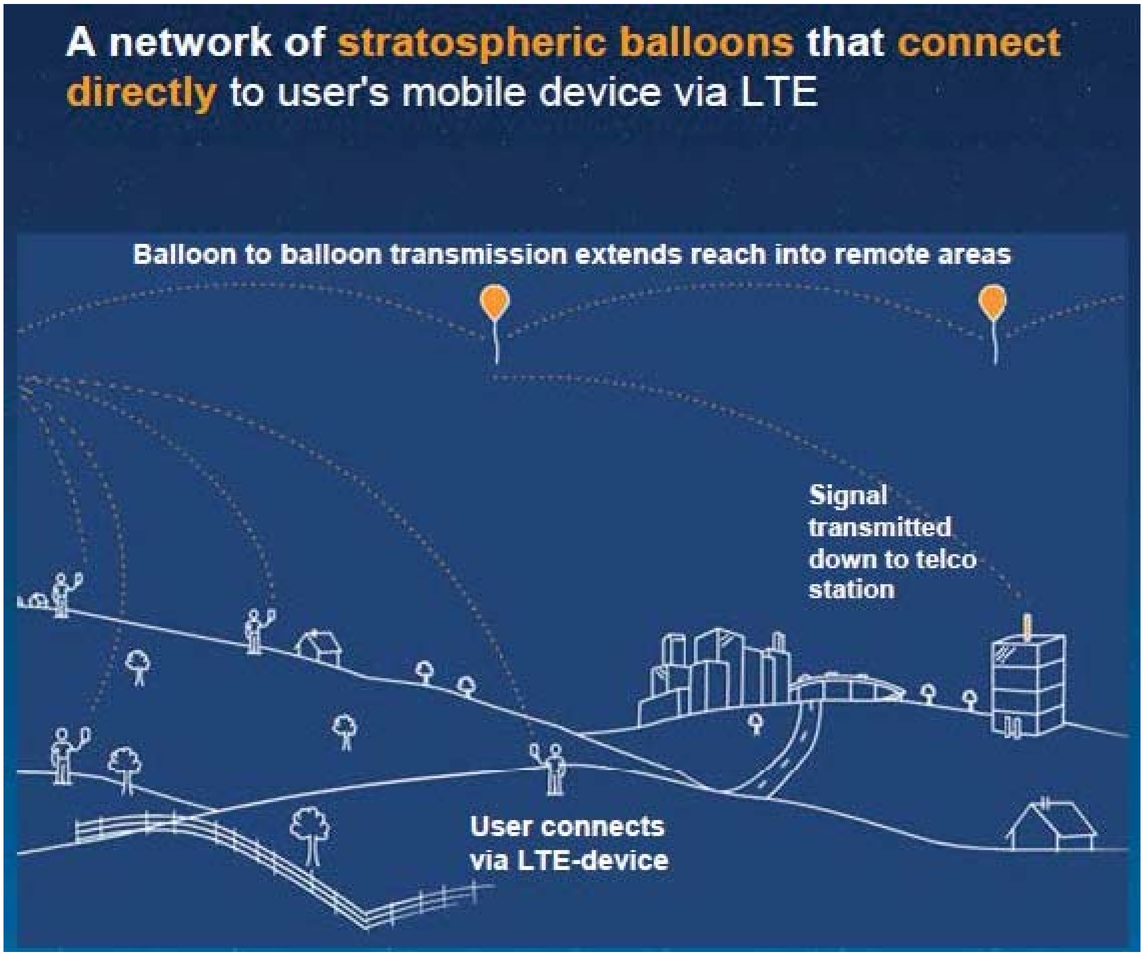
279. The Google Project Loon website shows that it has deployed a system wherein the transceiver is capable of communicating with a communication device that is separate from the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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280. The Google Project Loon website shows that it has deployed a system wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/) and the ICAO (International Civil Aviation Organization) Rules:

**Safety features**

**WE COMPLY WITH OR EXCEED ALL HEAVY UFB REQUIREMENTS (ICAO Rules of the Air, Annex 2, Appendix 5)**

3.3 A heavy unmanned free balloon shall not be operated unless:

a) it is equipped with at least two payload flight-termination devices or systems, whether automatic or operated by telecommand, that operate independently of each other;

b) for polyethylene zero-pressure balloons, at least two methods, systems, devices, or combinations thereof, that function independently of each other are employed for terminating the flight of the balloon envelope;

281. The Google Project Loon website shows that it has deployed a system wherein at least one of the geographical coordinates tracking system comprises a GPS, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

VISIBILITY ELEMENTS

**Triple Redundant Position Tracking**

1. Transponder (ADS-B out with Mode A/C)
2. Web based GPS
3 Iridium triangulation

**Radar Reflective Materials**

**Omnidirectional light beacon ( > 5NM vis. )**

**AVIONICS SYSTEM**

Transponder/ADS-B out, GPS + sensor state information, transmitted via Iridium

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282. The Google Project Loon website shows that it has deployed a system wherein the unmanned balloon is configured to operate above an altitude of about 60,000 feet, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

> Transit occurs above 60,000 ft. In cases that we do transit below FL600, we coordinate with ATC.

283. The Google Project Loon website shows that it has deployed a system wherein the unmanned balloon has a flight duration capability that is longer than that of weather balloons that have flight durations of approximately 2 hours, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

> **FLIGHT**
>
> We aim to launch and maintain a fleet of balloons to provide Internet coverage to users on the ground, with our Autolaunchers capable of safely and consistently launching a new balloon every 30 minutes. We have flown over 19 million km of test flights to date since the project began - with one of our record-breaking balloons surviving for 190 days aloft in the stratosphere.

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284. The Google Project Loon website shows that it has deployed a system wherein the payload is configured to communicate with an additional airborne payload attached to a separate unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):


285. The Google Project Loon website shows that it has deployed a system wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon based on a determination that further operation of the unmanned balloon presents a danger to air traffic, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/) and the ICAO Rules:


> The operator of a heavy unmanned free balloon shall activate the appropriate termination devices required by 3.3 a) and b) above:
>
> a) when it becomes known that weather conditions are less than those prescribed for the operation;
>
> b) if a malfunction or any other reason makes further operation hazardous to air traffic or to persons or property on the surface; or
>
> c) prior to unauthorized entry into the airspace over another State's territory.

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286. The Google Project Loon website shows that it has deployed a system wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon based on a determination of a malfunction of the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

**Safety features**

**WE COMPLY WITH OR EXCEED ALL HEAVY UFB REQUIREMENTS (ICAO Rules of the Air, Annex 2, Appendix 5)**

> The operator of a heavy unmanned free balloon shall activate the appropriate termination devices required by 3.3 a) and b) above:
>
> a) when it becomes known that weather conditions are less than those prescribed for the operation;
>
> b) if a malfunction or any other reason makes further operation hazardous to air traffic or to persons or property on the surface; or
>
> c) prior to unauthorized entry into the airspace over another State's territory.

287. Defendants infringe claims of the '503 Patent. Defendants, without authority, make, use, offer to sell, and/or sell instrumentalities that practice systems and methods covered by claims of the '503 Patent. Google's Loon instrumentalities meet all of the elements of claims of the '503 Patent, including, as further detailed in paragraphs 270 to 286 above, all the elements of the '503 Patent, Claim 1. Defendants have been, and are currently, directly infringing at least claim 1 of the '503 Patent in violation of 35 U.S.C. § 271(a), literally or under the doctrine of equivalents, by its Google Loon instrumentalities, that practice the systems and/or methods disclosed in the '503 Patent. Defendants have been on notice of their infringement since at least the issuance date of the '503 Patent.

288. As a result of Defendants' direct infringement, Space Data has been and continues to be damaged and irreparably injured, including without limitation, the loss of sales and profits it would have earned but for Defendants' actions, and damage to Space Data's reputation among potential and existing customers, business partners, investors, and in the industry in general.

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289. Defendants will continue to irreparably harm Space Data unless enjoined. Space Data faces real, substantial and irreparable damage and injury of a continuing nature from infringement for which Space Data has no adequate remedy at law.

**COUNT VI**

**(Infringement of United States Patent No. 9,643,706 Against all Defendants)**

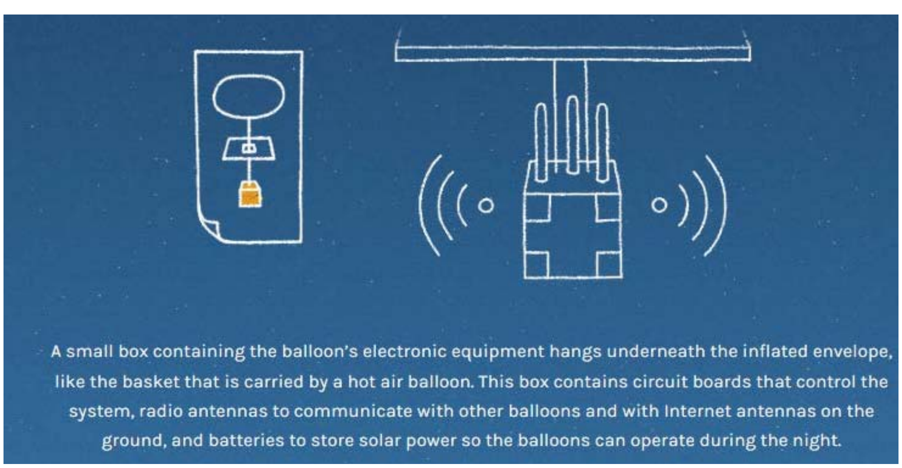
290. Space Data repeats, realleges, and incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 to 224 above.

291. On May 9, 2017, United States Patent No. 9,643,706, entitled "Systems and Applications of Lighter-Than-Air (LTA) Platforms," (the "'706 Patent") was duly and legally issued. A true and correct copy of the '706 Patent is attached hereto as Exhibit F and incorporated herein by reference.

292. Gerald M. Knoblach, Eric A. Frische and Bruce Alan Barkley are the inventors of the '706 Patent. Space Data is the assignee and owner of all right, title, and interest in and to the '706 Patent.

293. The systems practiced by Google's Project Loon infringes the '706 Patent.

294. The Google Project Loon website shows that it has deployed a system comprising an airborne platform comprising an unmanned balloon, a payload that is separate from the unmanned balloon, a transceiver, and first and second flight termination devices, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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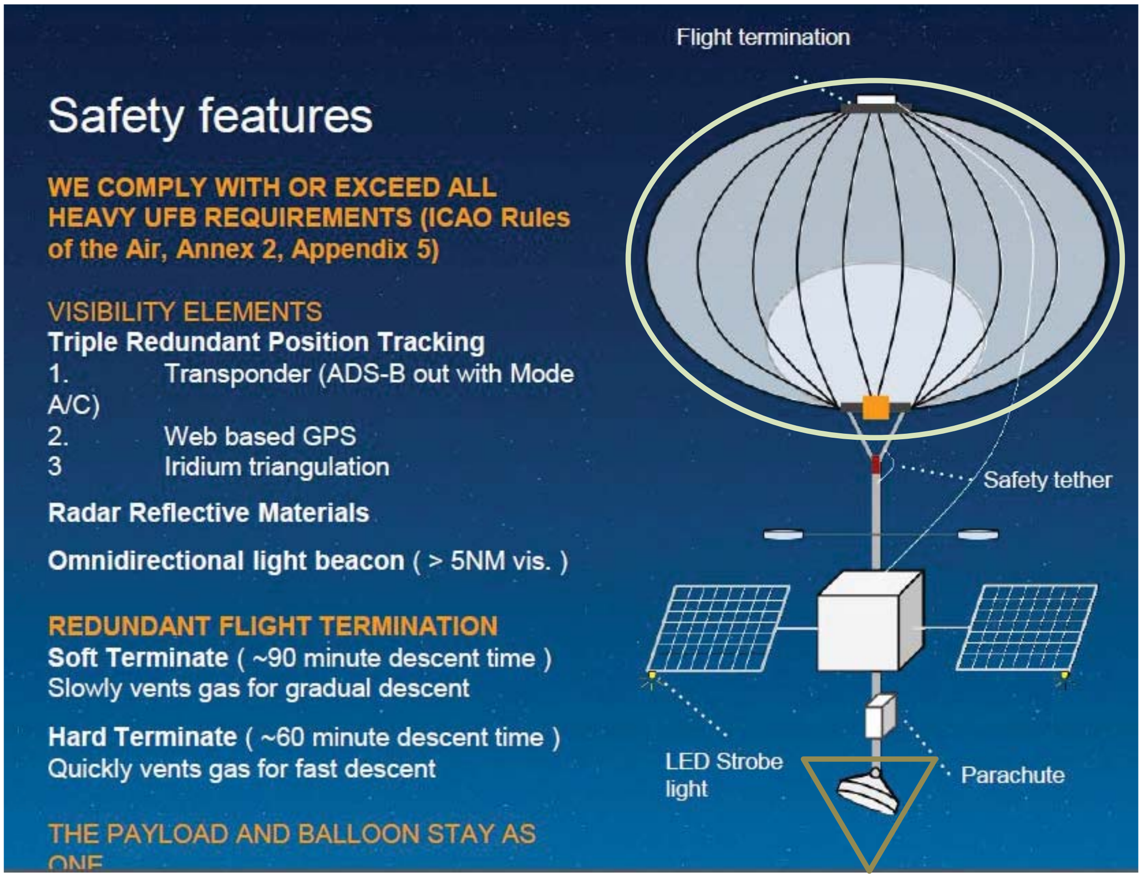


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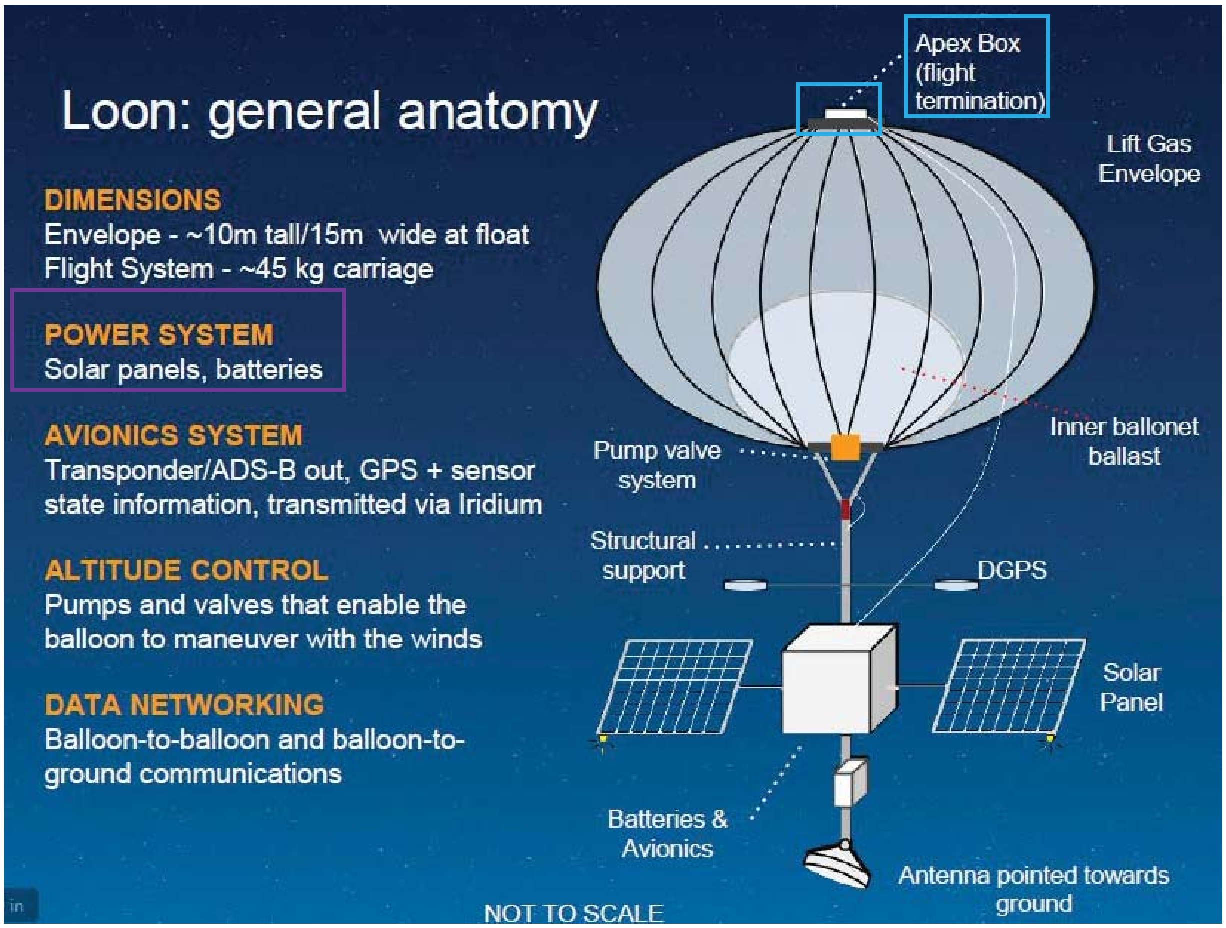
295. The Google Project Loon website shows that it has deployed a system with at least two separate power sources for the first and second flight termination devices, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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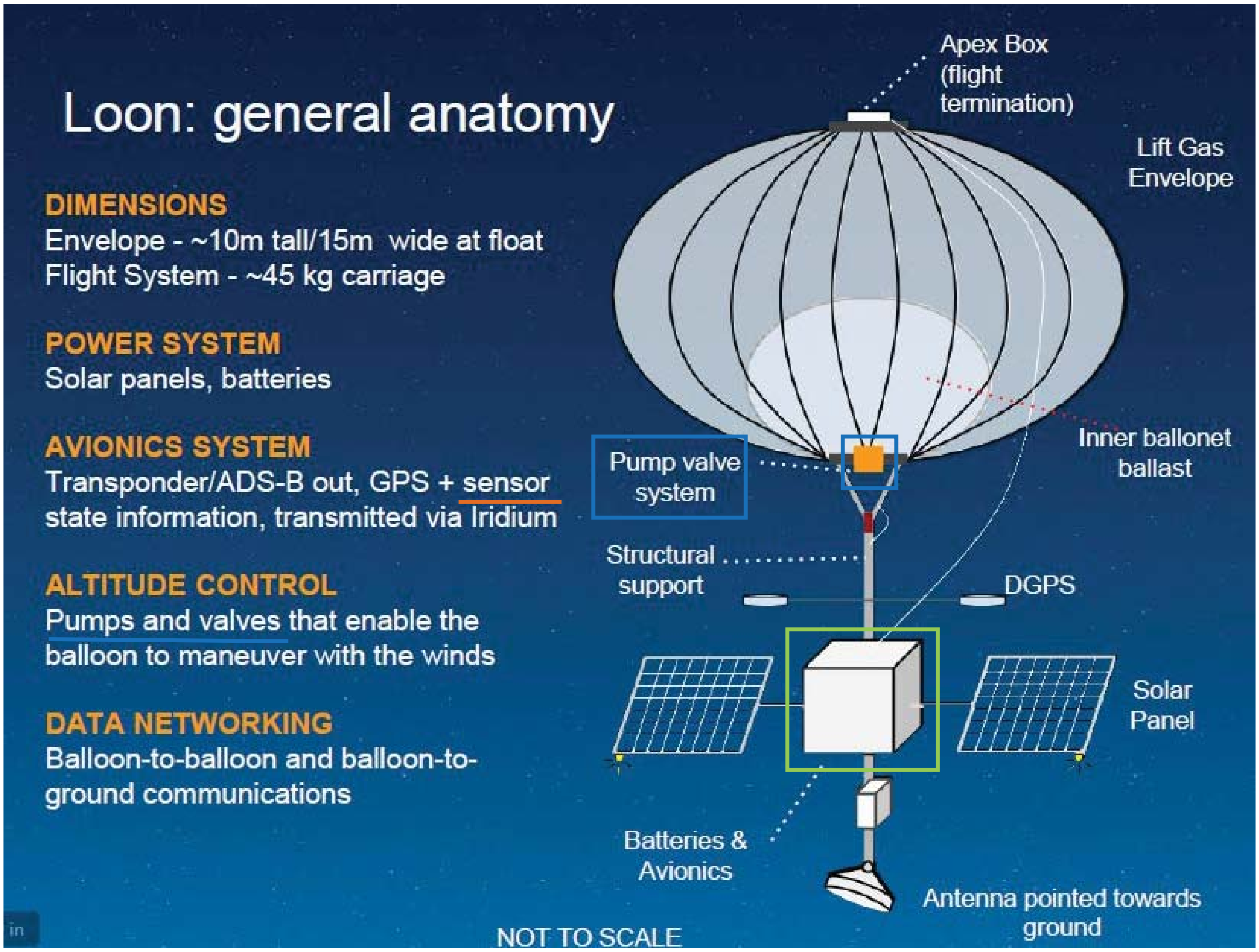
296. The Google Project Loon website shows that it has deployed a system with a sensor, a processor, a pump, and a valve, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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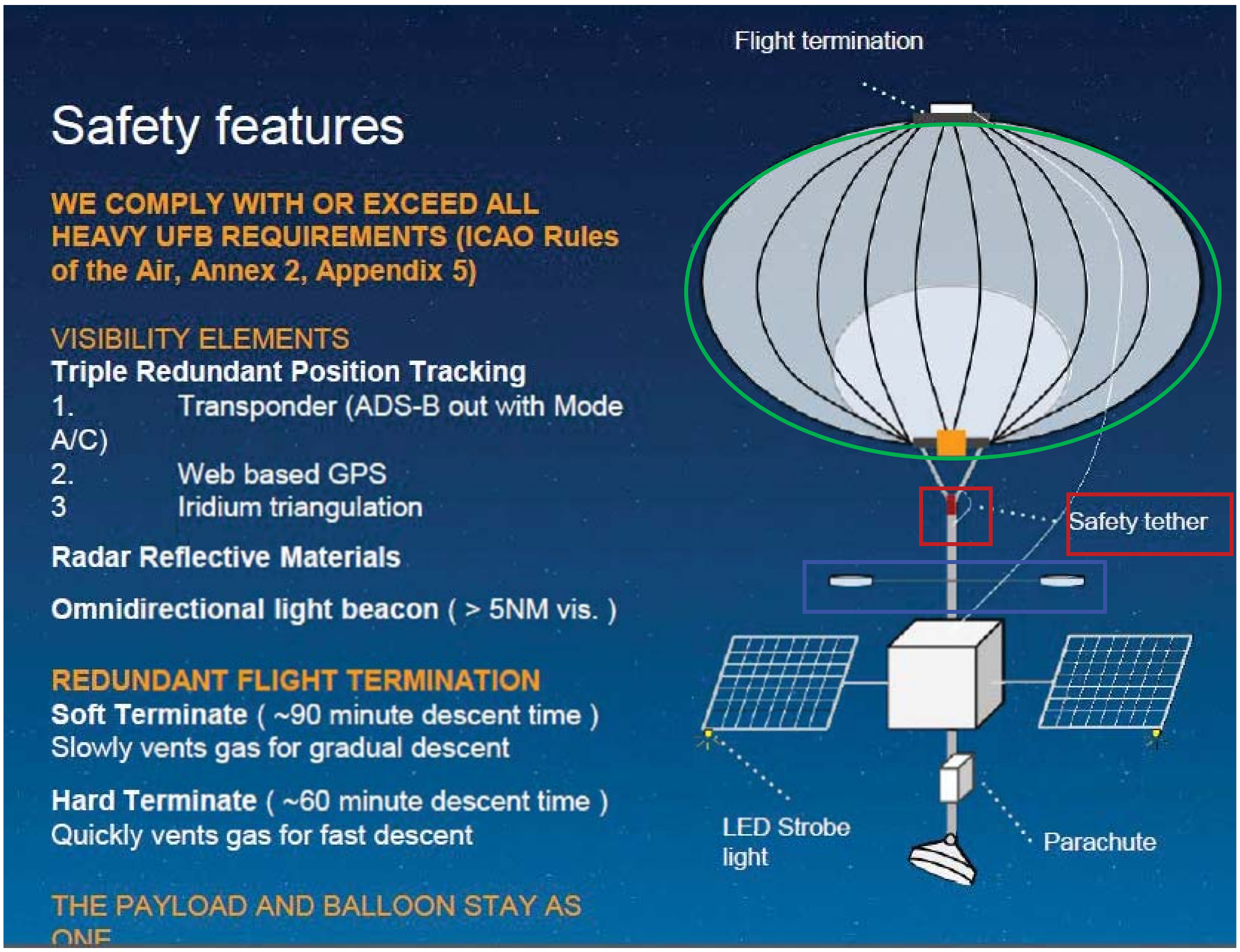
297. The Google Project Loon website shows that it has deployed a system with a tether that when broken separates the unmanned balloon and the payload, as shown in the following image captured from the Google Project Loon website (http://www.google.com/loon/how/):




298. The Google Project Loon website shows that it has deployed a system wherein the pump and the valve are configured to change an altitude of the airborne platform, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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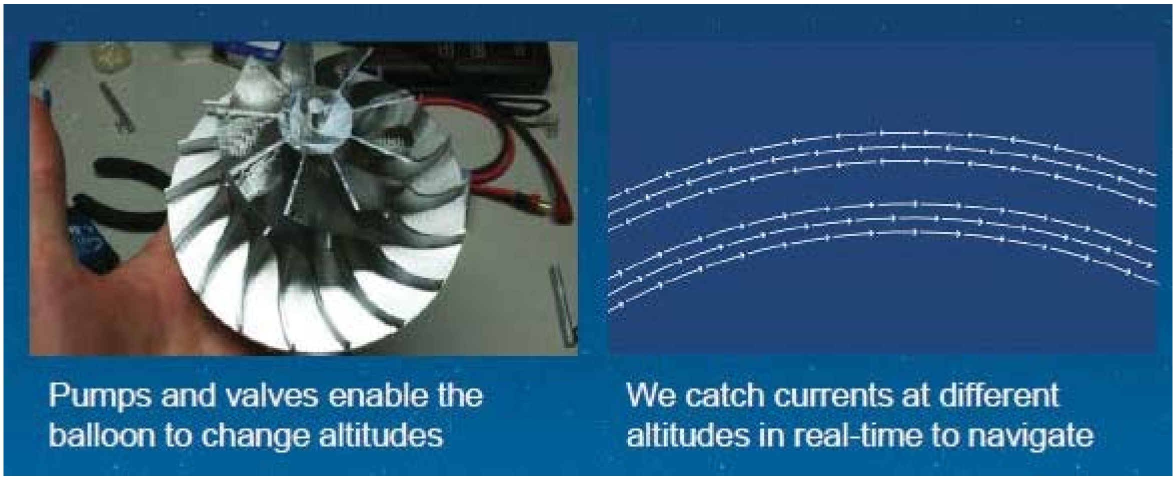


**ALTITUDE CONTROL**
Pumps and valves that enable the balloon to maneuver with the winds

299. The Google Project Loon website shows that it has deployed a system wherein the sensor comprises a pressure sensor, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

**AVIONICS SYSTEM**
Transponder/ADS-B out, GPS + sensor state information, transmitted via Iridium

**Estimated Life Expectancy** : Through multiple sensors, our flight systems constantly check indicators of balloon life (e.g., temperature and pressure).

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300. The Google Project Loon website shows that it has deployed a system wherein, in operation, the unmanned balloon substantially drifts along with the wind currents, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):


301. The Google Project Loon website shows that it has deployed a system wherein the transceiver is capable of communicating with a communication device that is separate from the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

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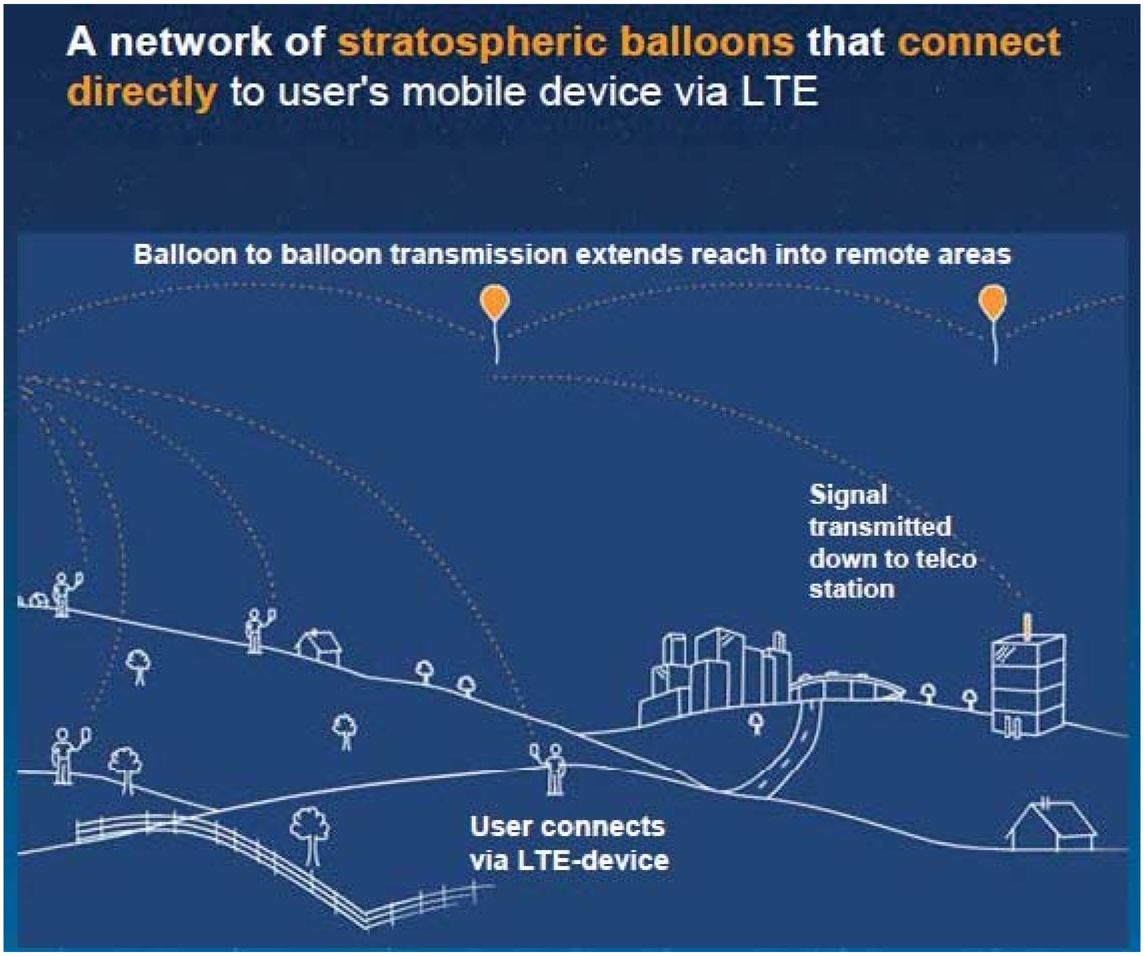


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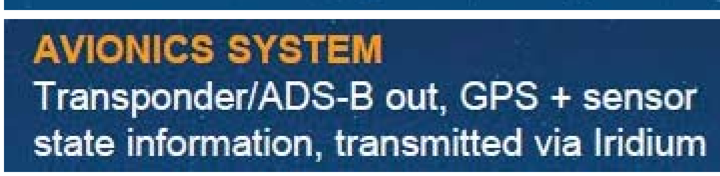
302. The Google Project Loon website shows that it has deployed a system wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/) and the ICAO Rules:


3.3 A heavy unmanned free balloon shall not be operated unless:

a) it is equipped with at least two payload flight-termination devices or systems, whether automatic or operated by telecommand, that operate independently of each other;

b) for polyethylene zero-pressure balloons, at least two methods, systems, devices, or combinations thereof, that function independently of each other are employed for terminating the flight of the balloon envelope;

303. The Google Project Loon website shows that it has deployed a system wherein at least one of the geographical coordinates tracking system comprises a GPS, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):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304. The Google Project Loon website shows that it has deployed a system wherein the unmanned balloon is configured to operate above an altitude of about 60,000 feet, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

> Transit occurs above 60,000 ft. In cases that we do transit below FL600, we coordinate with ATC.

305. The Google Project Loon website shows that it has deployed a system wherein the unmanned balloon has a flight duration capability that is longer than that of weather balloons that have flight durations of approximately 2 hours, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):

> FLIGHT
>
> We aim to launch and maintain a fleet of balloons to provide Internet coverage to users on the ground, with our Autolaunchers capable of safely and consistently launching a new balloon every 30 minutes. We have flown over 19 million km of test flights to date since the project began - with one of our record-breaking balloons surviving for 190 days aloft in the stratosphere.

306. The Google Project Loon website shows that it has deployed a system wherein the payload is configured to communicate with an additional airborne payload attached to a separate

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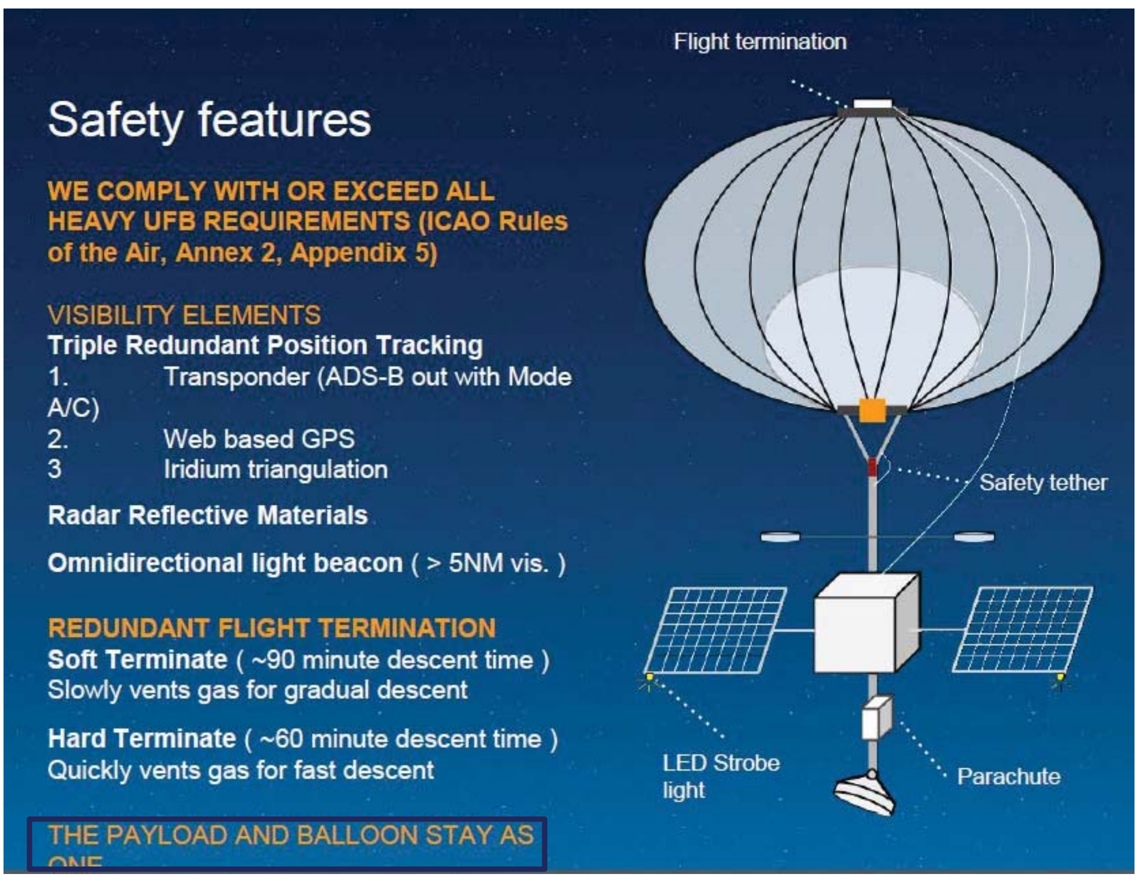
unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):


307. The Google Project Loon website shows that it has deployed a system wherein the payload remains attached to the unmanned balloon as one when landed unless the payload is separated from the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com /loon/how/):




308. The Google Project Loon website shows that it has deployed a system wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon based on a determination that further operation of the unmanned balloon

presents a danger to air traffic, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/) and the ICAO Rules:


> The operator of a heavy unmanned free balloon shall activate the appropriate termination devices required by 3.3 a) and b) above:
>
> a) when it becomes known that weather conditions are less than those prescribed for the operation;
>
> b) if a malfunction or any other reason makes further operation hazardous to air traffic or to persons or property on the surface; or
>
> c) prior to unauthorized entry into the airspace over another State's territory.

309. The Google Project Loon website shows that it has deployed a system wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon based on a determination of a malfunction of the unmanned balloon, as shown in the following information captured from the Google Project Loon website (http://www.google.com/loon/how/):


> The operator of a heavy unmanned free balloon shall activate the appropriate termination devices required by 3.3 a) and b) above:
>
> a) when it becomes known that weather conditions are less than those prescribed for the operation;
>
> b) if a malfunction or any other reason makes further operation hazardous to air traffic or to persons or property on the surface; or
>
> c) prior to unauthorized entry into the airspace over another State's territory.

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310. Defendants infringe claims of the ’706 Patent. Defendants, without authority, make, use, offer to sell, and/or sell instrumentalities that practice systems covered by claims of the ’706 Patent. Google’s Loon instrumentalities meet all of the elements of claims of the ’706 Patent, including, as further detailed in paragraphs 294 to 309 above, all the elements of the ’706 Patent, Claim 29. Defendants have been, and are currently, directly infringing at least claim 29 of the ’706 Patent in violation of 35 U.S.C. § 271(a), literally or under the doctrine of equivalents, by its Google Loon instrumentalities, that practice the systems disclosed in the ’706 Patent. Defendants have been on notice of their infringement since at least the issuance date of the ’706 Patent.

311. As a result of Defendants’ direct infringement, Space Data has been and continues to be damaged and irreparably injured, including without limitation, the loss of sales and profits it would have earned but for Defendants’ actions, and damage to Space Data’s reputation among potential and existing customers, business partners, investors, and in the industry in general.

312. Defendants will continue to irreparably harm Space Data unless enjoined. Space Data faces real, substantial and irreparable damage and injury of a continuing nature from infringement for which Space Data has no adequate remedy at law.

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## **PRAYER FOR RELIEF**

WHEREFORE, Space Data prays for entry of judgment as follows:

A. judgment in Space Data’s favor and against Defendants on all causes of action alleged herein;

B. that Defendants breached the NDA;

C. for damages in an amount to be further proven at trial;

D. that Defendants be ordered to disgorge, restore and/or make restitution to Space Data for all sums constituting unjust enrichment from their wrongful conduct, as allowed by law according to proof;

E. that the patents-in-suit are valid and enforceable;

F. that Defendants have infringed one or more claims of each of the patents-in-suit;

G. that Defendants’ infringement of the ’941 Patent was willful;

H. that Defendants account for and pay to Space Data all damages caused by the

infringement of the patents-in-suit, which by statute can be no less than a reasonable royalty with respect to each patent-in-suit;

I. that the damages to Space Data with respect to the '941 Patent be increased by three times the amount found or assessed pursuant to 35 U.S.C. § 284 and that the Defendants account for and pay to Space Data the increased amounts;

J. that this be adjudicated an exceptional case and Space Data be awarded its attorneys' fees in this action pursuant to 35 U.S.C. § 285;

K. that Defendants have wrongfully misappropriated Space Data's trade secrets;

L. that Defendants account for and pay to Space Data all damages caused by the misappropriation of Space Data's trade secrets, which pursuant to Cal. Civ. Code § 3426.3, includes actual loss and any unjust enrichment not taken into account in computing actual loss, or a reasonable royalty if neither damages nor unjust enrichment is provable;

M. that Defendants' misappropriation of Space Data's trade secrets was willful and malicious, and for exemplary damages pursuant to Cal. Civ. Code § 3426.3(c), and reasonable attorneys' fees and costs (including expert expenses) pursuant to Cal. Civ. Code § 3426.4;

N. that Defendants account for and pay to Space Data all damages caused by the misappropriation of Space Data's trade secrets which, pursuant to 18 U.S.C. § 1836(b)(3)(B), includes actual loss and any unjust enrichment not addressed in computing damages for actual loss, or a reasonable royalty in lieu of damages measured by another method;

O. that Defendants' misappropriation of Space Data's trade secrets was willful and malicious, and for exemplary damages pursuant to 18 U.S.C. § 1836(b)(3)(C), and reasonable attorneys' fees pursuant to 18 U.S.C. § 1836(b)(3)(D);

P. that this Court issue preliminary and final injunctions enjoining the Defendants, their officers, agents, servants, employees and attorneys, and any other person in active concert or participation with them, from continuing the acts herein

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complained of with respect to infringement of the patents-in-suit, and more particularly, that Defendants and such other persons be permanently enjoined and restrained form further infringing the patents-in-suit;

Q. that this Court issue preliminary and final injunctions enjoining the Defendants, their officers, agents, servants, employees and attorneys, and any other person in active concert or participation with them, prohibiting them from: continuing to use Space Data's trade secrets; continuing to use Space Data's Confidential Information; continuing to disclose Space Data's trade secrets; continuing to disclose Space Data's Confidential Information; continuing to breach the proprietary, confidentiality and use limitation provisions of the NDA; continuing to exercise ownership over Space Data's trade secrets; and continuing to exercise ownership over Space Data's Confidential Information;

R. that this Court require Defendants to file with this Court, within thirty (30) days after entry of final judgment, a written statement under oath setting forth in detail the manner in which Defendants have complied with the injunctions;

S. that Space Data be granted pre-judgment and post-judgment interest on the damages caused to them by reason of Defendants' conduct at the maximum legal rates provided by statute or law;

T. that this Court award Space Data its costs and disbursements in this civil action, including reasonable attorneys' fees; and

U. that Space Data be granted such other and further relief as the Court may deem just and proper under the circumstances.

Respectfully submitted,

Dated: _________, 2017

By: ________________________________
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*Attorneys for Plaintiff, Space Data Corporation*

**DEMAND FOR JURY TRIAL**

Space Data demands a jury trial on all causes of action, claims or issues in this action that are triable as a matter of right to a jury.

Respectfully submitted,

Dated: __________, 2017

By: ______________________________

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# EXHIBIT A

**GOOGLE INC.**

**MUTUAL CONFIDENTIALITY AND NONDISCLOSURE AGREEMENT**

This Mutual Non-Disclosure Agreement ("Agreement") is made and entered into between Google Inc. ("Google"), and Space Data, Inc., for itself and its subsidiaries and affiliates ("Company"), individually referred to as a "Party" and collectively referred to as the "Parties." Google and Company intend to engage in discussions and negotiations concerning a proposed acquisition of shares or assets of Company (the "Transaction") and it is anticipated that the Parties will disclose or deliver to the other Party certain trade secrets or confidential or proprietary information and Google and Company are entering into this Agreement in order to assure the confidentiality of such trade secrets and confidential or proprietary information in accordance with the following terms:

1. The Effective Date of this Agreement is December 1, 2007.

2. In connection with the Transaction, a Party (the "Discloser") may disclose certain information it considers confidential or proprietary ("Confidential Information") to the other Party (the "Recipient"), whether in furtherance or continuance of an established business relationship or the Transaction or for the purpose of enabling the Parties to evaluate the feasibility of a business relationship or the Transaction, including, but not limited to, tangible, intangible, visual, electronic, present, or future information about the Discloser's business, business plans, pricing, customers, strategies, trade secrets, operations, records, finances, assets, technology, algorithms, data and information that reveals the processes, designs, methodologies, technology or know how by which the Discloser's existing or future products, services, applications and methods of operation are developed, conducted or operated. Company and Google are entering into this Agreement in order to assure the confidentiality of such confidential or proprietary information in accordance with the terms of this Agreement.

3. Information shall only be considered Confidential Information for the purposes of this Agreement (a) if it is clearly and conspicuously marked as "confidential" or with a similar designation; or (b) if it is identified as confidential and/or proprietary before, during, or promptly after presentation or communication by Discloser. Information communicated orally shall only be considered Confidential Information if such information is designated as being confidential at the time of disclosure (or promptly thereafter) and is reduced in writing and confirmed to the Recipient as being Confidential Information within fifteen (15) days after the initial disclosure.

4. The Recipient shall hold in confidence, and shall not disclose to any person outside its organization (other than its affiliates and its and their respective agents, contractors, representatives or advisors (collectively, "Representatives") who have a need to know such information for the purposes of evaluating the Transaction): (i) any Confidential Information; (ii) the fact that discussions or negotiations between the Parties to this Agreement are taking or have taken place; (iii) any of the terms, conditions or other facts with respect to the subject matter of this Agreement; or (iv) the fact that this Agreement exists or information has been requested or made available to the Recipient or its Representatives (except that either Party may make any disclosure otherwise prohibited under clauses (i), (ii), (iii) or (iv) above if, in the opinion of its legal counsel, such disclosure is required by applicable law or stock exchange regulation). The Recipient and its personnel shall use such Confidential Information only for the purposes set forth above. The Recipient will use the same degree of care, but no less than a

reasonable degree of care, as the Recipient uses with respect to its own confidential information to: (i) protect the confidentiality of Confidential Information; and (ii) ensure that proper and secure storage is provided for all Confidential Information to protect against theft or unauthorized access.

5. This Agreement imposes no obligation upon a Recipient with respect to Confidential Information that: (a) was known to the Recipient before receipt from the Discloser; (b) is or becomes publicly available through no fault of the Recipient; (c) is received by the Recipient from a third party without a duty of confidentiality; (d) is independently developed by the Recipient without a breach of this Agreement; or (e) is disclosed by the Recipient with the Discloser's prior written approval.

6. This Agreement shall remain in effect until it is terminated by either Party with thirty (30) days prior written notice. Notwithstanding the foregoing, this Agreement shall survive with respect to Confidential Information that is disclosed before the effective date of termination.

7. Unless the Parties otherwise agree in writing, a Recipient's duty to protect Confidential Information expires three (3) years from the date of disclosure. A Recipient, upon Discloser's written request, will promptly return or destroy all Confidential Information received from the Discloser, together with all copies. Regardless of whether the Confidential Information is returned or destroyed, the Recipient may retain an archival copy of the Discloser's Confidential Information for use solely in the event a dispute arises hereunder and only in connection with such dispute.

8. No Party acquires any intellectual property rights under this Agreement (including, but not limited to, patent, copyright, and trademark rights) except the limited rights necessary to carry out the purposes set forth in this Agreement. Notwithstanding anything herein to the contrary, Company recognizes that Google may in the future develop products or services related to or similar to the subject matter of Confidential Information disclosed under this Agreement. Accordingly, Google may use Residuals for any purpose, including without limitation, use in the acquisition, development, manufacture, promotion, sale, or maintenance of products and services; provided that this right to Residuals does not represent a license under any intellectual property and/or proprietary rights of the Company. The term "Residuals" means information that is retained in the unaided memories of Google's employees or Representatives who have had access to Confidential Information pursuant to the terms of this Agreement. A person's memory is unaided if such person has not intentionally memorized the Confidential Information for the purpose of retaining and subsequently using or disclosing it.

9. Company acknowledges that the United States securities laws and other laws prohibit any person or entity who has material, non-public information concerning Google from purchasing or selling any of its securities, and from communicating such information to any person or entity under circumstances in which it is reasonably foreseeable that such person is likely to purchase or sell such securities.

10. Each Discloser warrants that it has the right to disclose its confidential or proprietary information. The Parties understand that neither Party accepts responsibility for, has made, makes, will make or is authorized to make any express or implied representation or warranty as to the accuracy, reliability or completeness of any of the Confidential Information. Each Party agrees that unless and until a definitive agreement between the Parties with respect to the Transaction has been executed and delivered, neither of the Parties will be under any legal obligation with respect to such a transaction by virtue of this Agreement or any written or oral expression with respect to such a transaction except as specifically set forth in this Agreement. Each Party reserves the right, in its

absolute discretion and without giving any reasons, at any time and in any respect to terminate discussions with the other Party with respect to the Transaction.

11. Company agrees that, without the prior written consent of Google, neither the Company nor any of its Representatives will initiate any communications concerning the subject matter of this Agreement through any director, officer or employee of Google or any of its subsidiaries who has not been specifically designated by Google as an authorized contact person with respect to the Transaction. In particular, unless otherwise instructed in writing (which may include an email communication) by a previously authorized contact person within Google, Company will direct all communications and all materials containing Confidential Information only to its main contact person within the Corporate Development department; and Company will not send any Confidential Information that is not specifically requested by Google.

12. Each Party acknowledges that damages for improper disclosure of Confidential Information may be irreparable; therefore, the injured Party is entitled to seek equitable relief, including injunction and preliminary injunction, in addition to all other remedies available to it.

13. This Agreement does not create any agency or partnership relationship. This Agreement will not be assignable or transferable by either Party without the prior written consent of the other Party; provided that either Party may assign this Agreement to any of its wholly owned affiliates or in connection with a change of control transaction.

14. This Agreement may be executed in two or more identical counterparts, each of which shall be deemed to be an original and all of which taken together shall be deemed to constitute the agreement when a duly authorized representative of each Party has signed the counterpart.

15. Wherever possible, each provision of this Agreement shall be interpreted in such manner as to be effective and valid under applicable law, but if any provision of this Agreement shall be prohibited by or invalid under applicable law, such provision shall be deemed modified to the extent necessary to make it enforceable under applicable law. If any such provision is not enforceable as set forth in the preceding sentence, the unenforceability of such provision shall not affect the other provisions of this Agreement, but this Agreement shall be construed as if such unenforceable provision had never been contained herein.

16. This Agreement constitutes the entire agreement between the Parties with respect to the subject matter hereof, and supersedes any prior oral or written agreements, and all contemporaneous oral communications. All additions or modifications to this Agreement must be made in writing and must be signed by the Parties. Any failure to enforce a provision of this Agreement shall not constitute a waiver thereof or of any other provision.

17. This Agreement shall be governed by the laws of the State of California, without reference to conflict of laws principles. The exclusive venue for any dispute shall be in the state or federal courts within Santa Clara County, California.

[THE SIGNATURE PAGE IS THE NEXT PAGE]

**IN WITNESS WHEREOF**, the parties have duly executed this Agreement as of the dates written in the signature blocks below.

| | |
|---|---|
| Google Inc. | Space Data, Inc. |
| By:__________ | By: *Gerald M. Knoblach* |
| Name: Matthew Sucherman | Name: Gerald M. Knoblach |
| Title: Associate General Counsel | Title: Chairman / CEO |
| Date: December 1, 2007 | Date: December 4, 2007 |

# EXHIBIT B

US006628941B2

(12) **United States Patent**
**Knoblach et al.**

(10) **Patent No.: US 6,628,941 B2**
(45) **Date of Patent: *Sep. 30, 2003**

(54) **AIRBORNE CONSTELLATION OF COMMUNICATIONS PLATFORMS AND METHOD**

(75) Inventors: **Gerald M. Knoblach**, Chandler, AZ (US); **Eric A. Frische**, Plano, TX (US)

(73) Assignee: **Space Data Corporation**, Chandler, AZ (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/342,440**

(22) Filed: **Jun. 29, 1999**

(65) **Prior Publication Data**

US 2002/0072361 A1 Jun. 13, 2002

(51) **Int. Cl.**$^{7}$ .................................................. **H04Q 7/20**
(52) **U.S. Cl.** ........................................ **455/431**; 455/436
(58) **Field of Search** .............................. 455/12.1, 13.1, 455/427, 430, 431, 11.1, 436; 244/158 R, 24, 31

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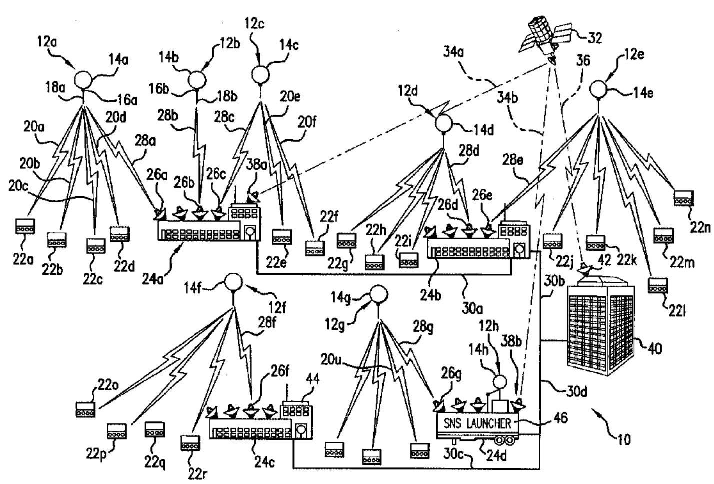
*Primary Examiner*—Nguyen T. Vo
(74) *Attorney, Agent, or Firm*—Morrison & Foerster LLP

(57) **ABSTRACT**

An airborne constellation is disclosed with a plurality of individual lighter-than-air platforms spaced apart above a contiguous geographic area within a predetermined altitude range so that ubiquitous line of sight coverage of the geographic area is provided. Each of the plurality of platforms include an enclosure holding a regulated volume of low density gas for buoyancy of the platforms. Each of the plurality of platforms further includes a signal transmitting device attached to the enclosure by which signals from the platform may be transmitted to the contiguous geographic area.

**73 Claims, 14 Drawing Sheets**



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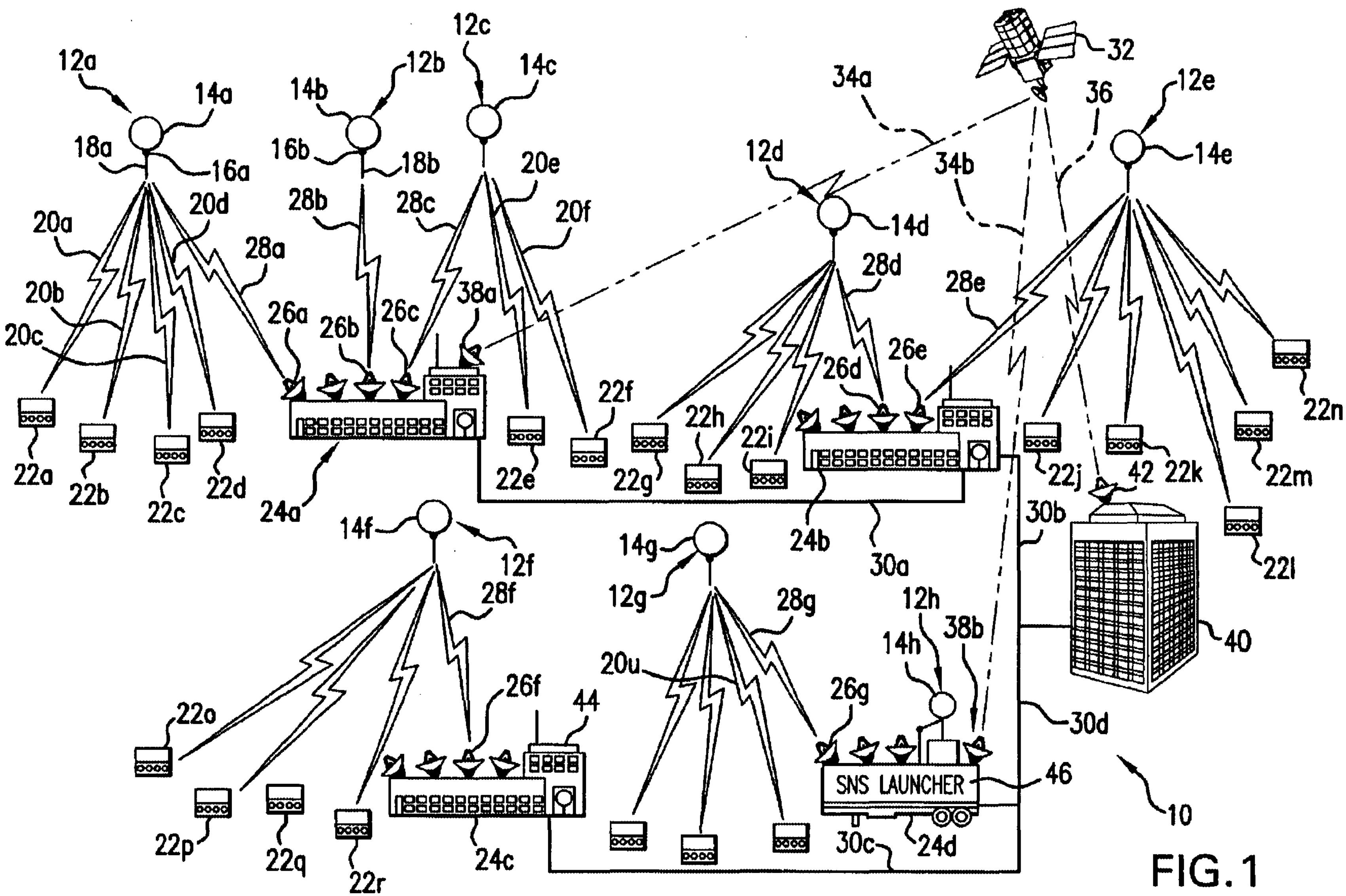



FIG. 1

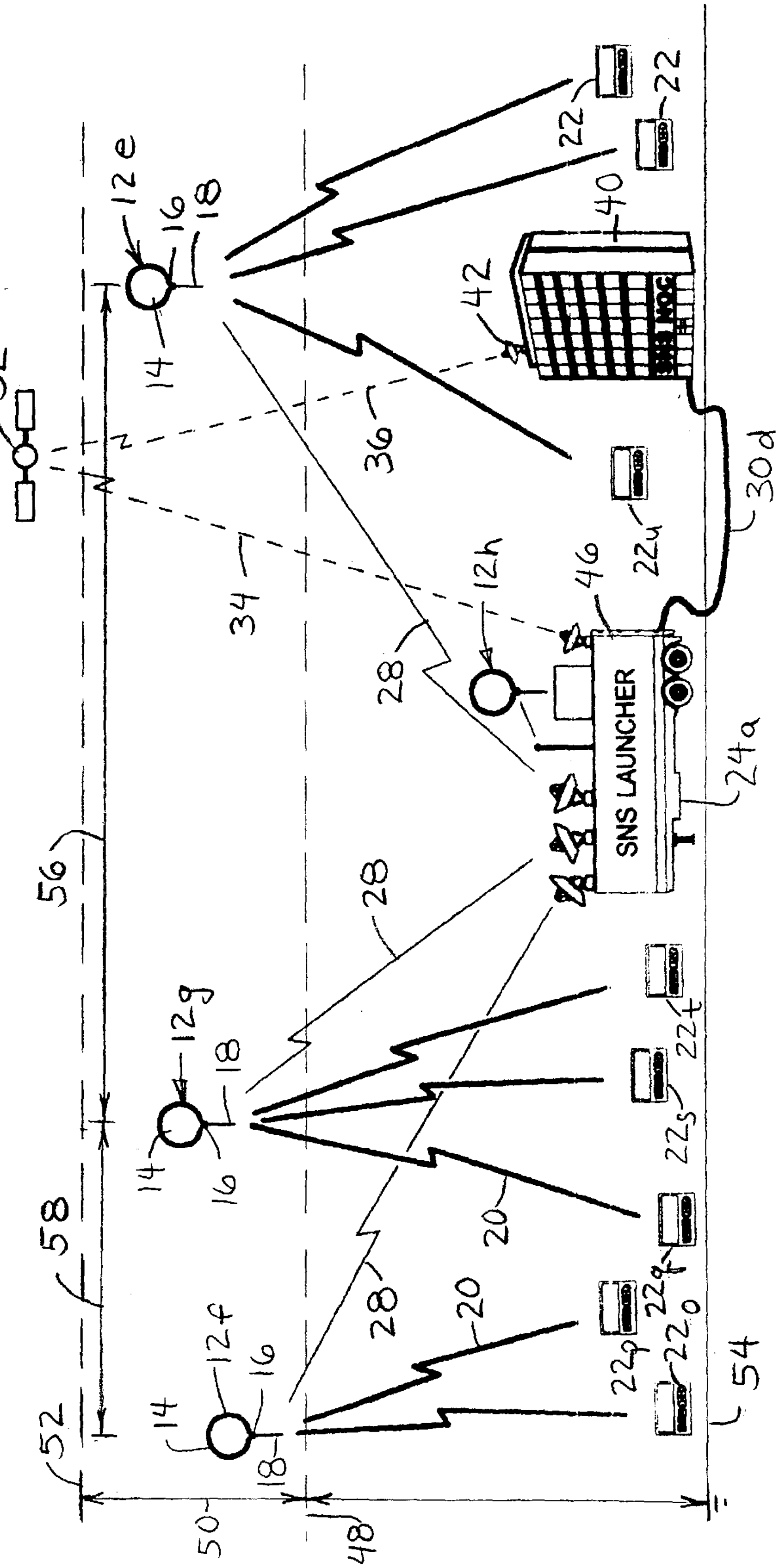
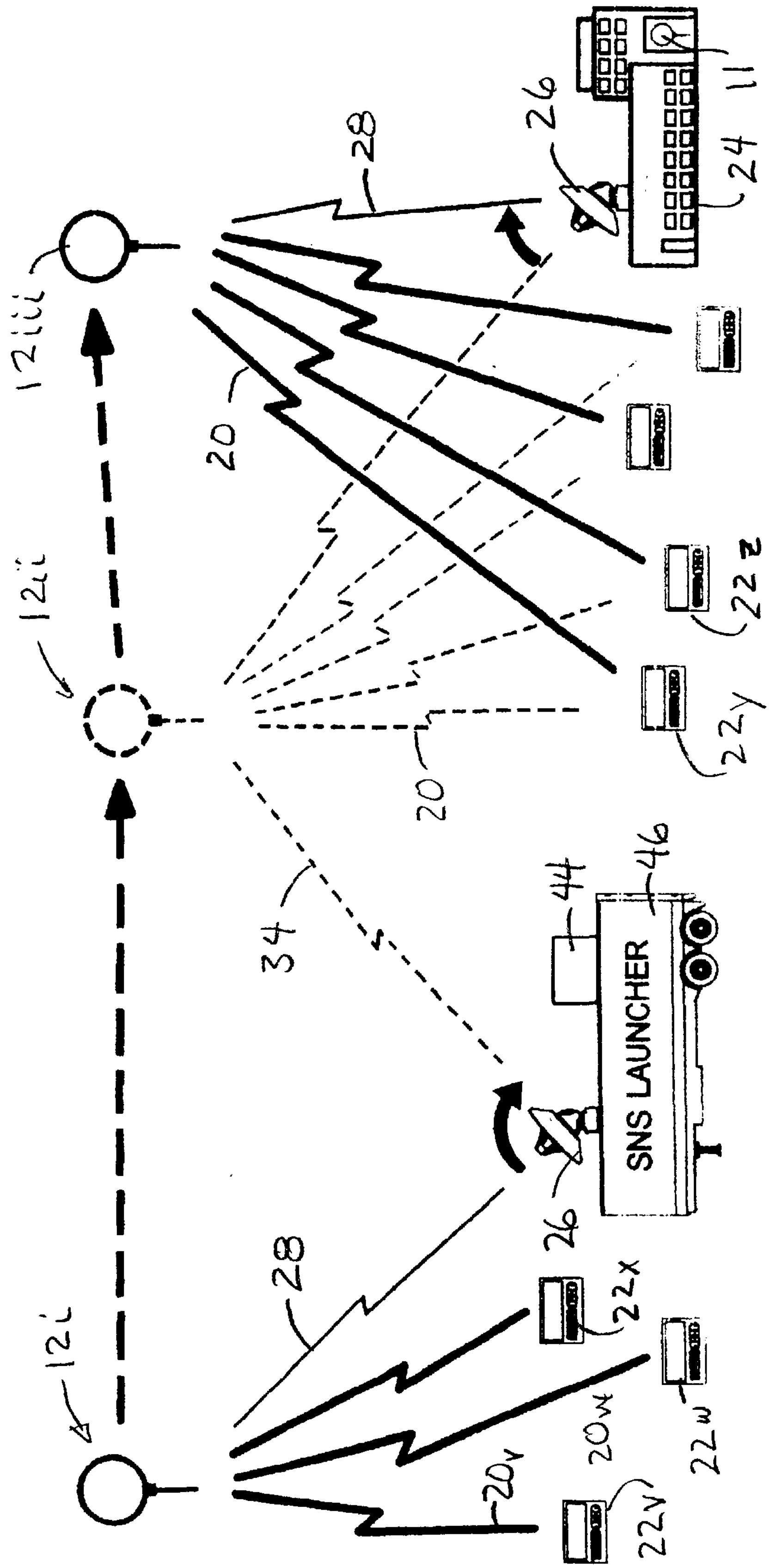



FIG. 2



12iii
12ii
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22z
22y
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SNS LAUNCHER
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22x
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20v
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FIG. 3

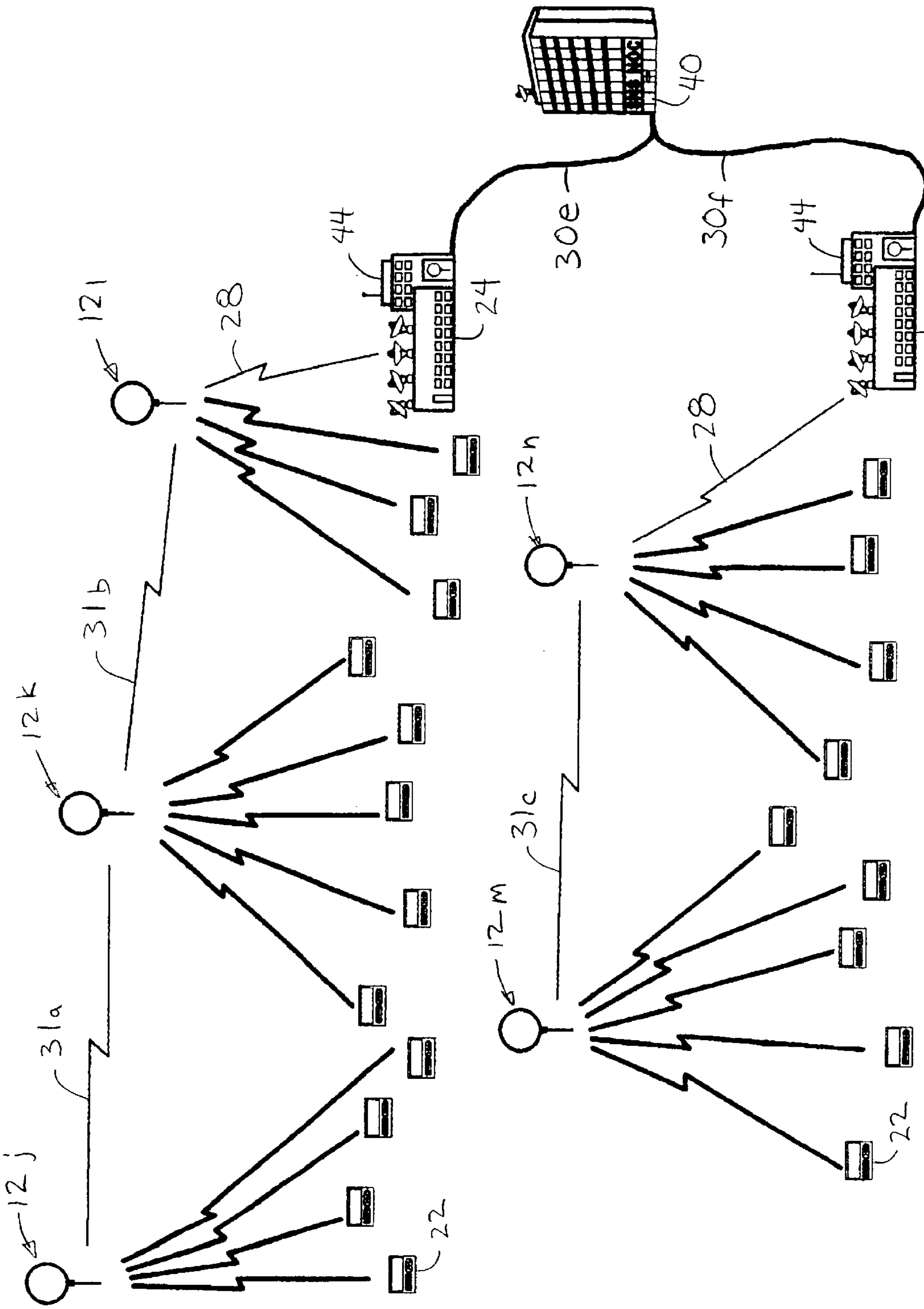


FIG. 4

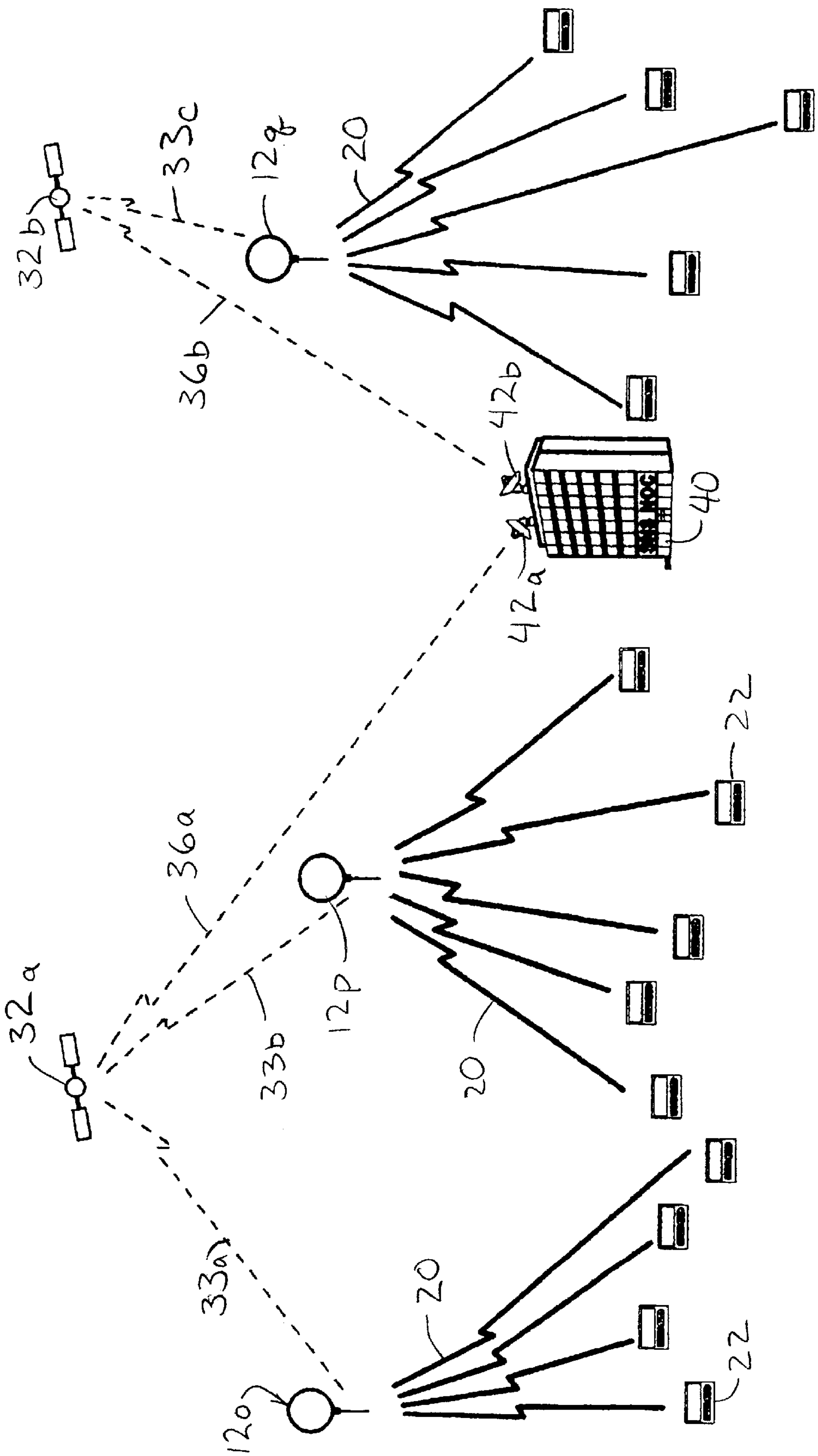


FIG. 5

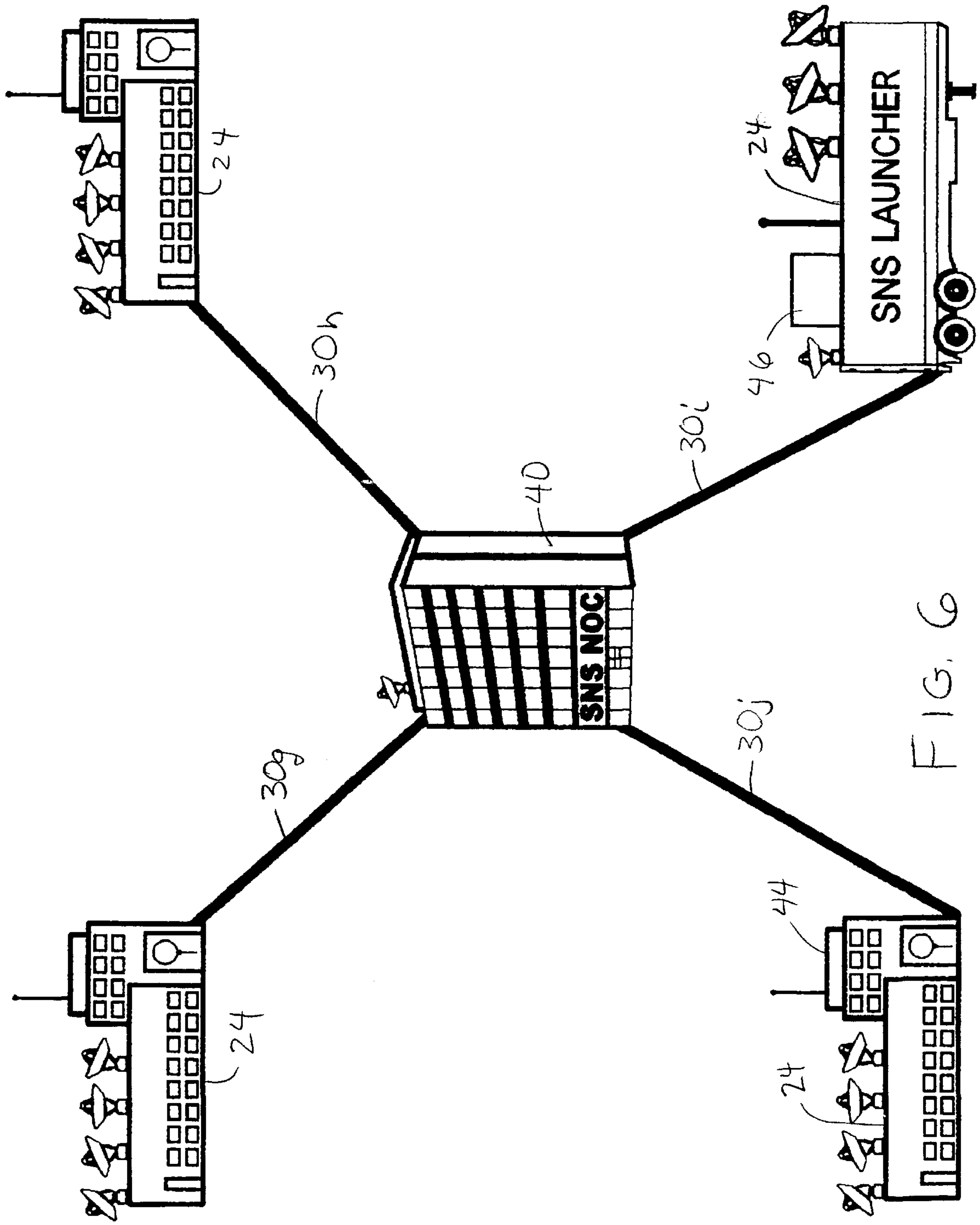


FIG. 6

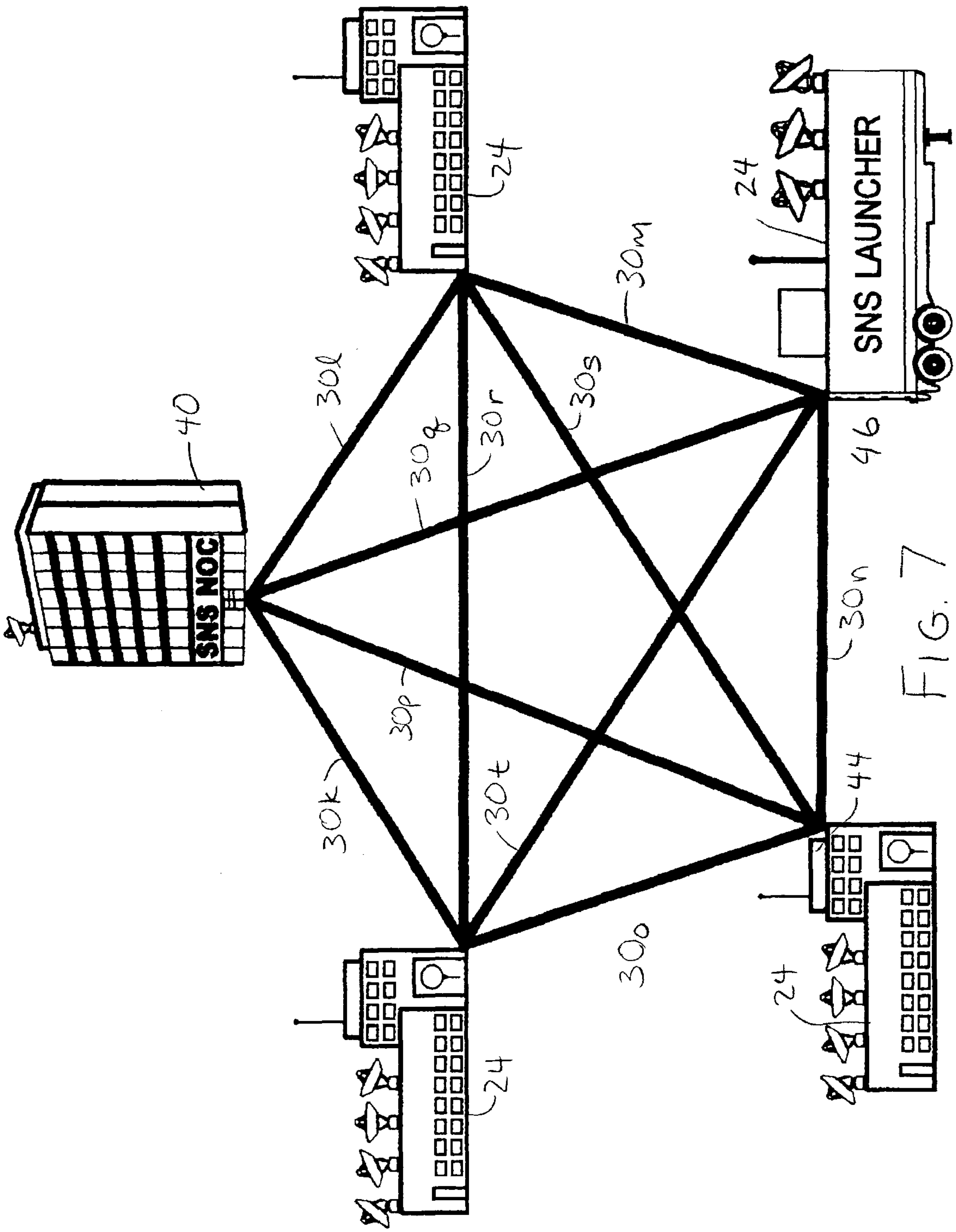
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FIG. 7

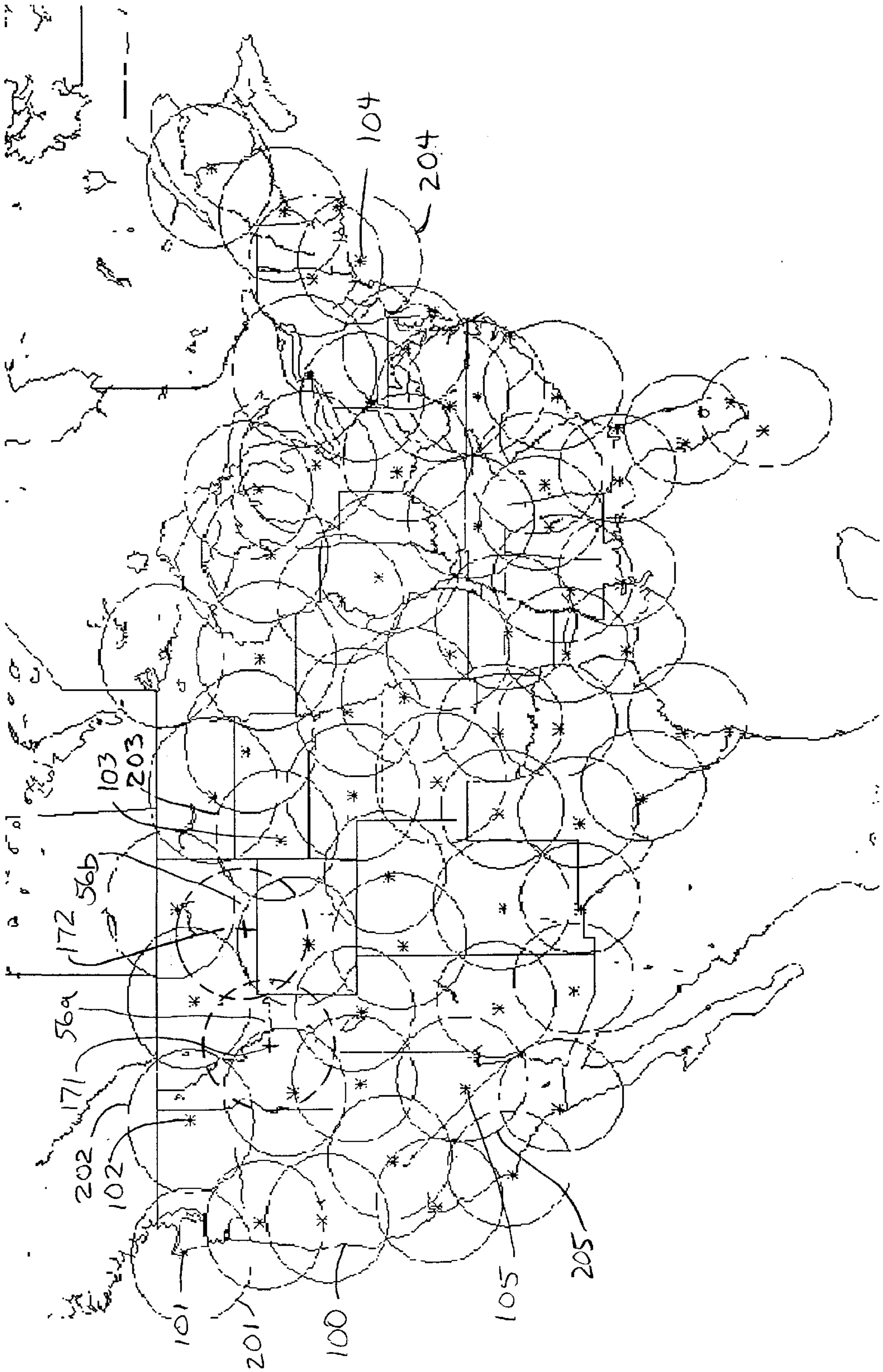


FIG. 8

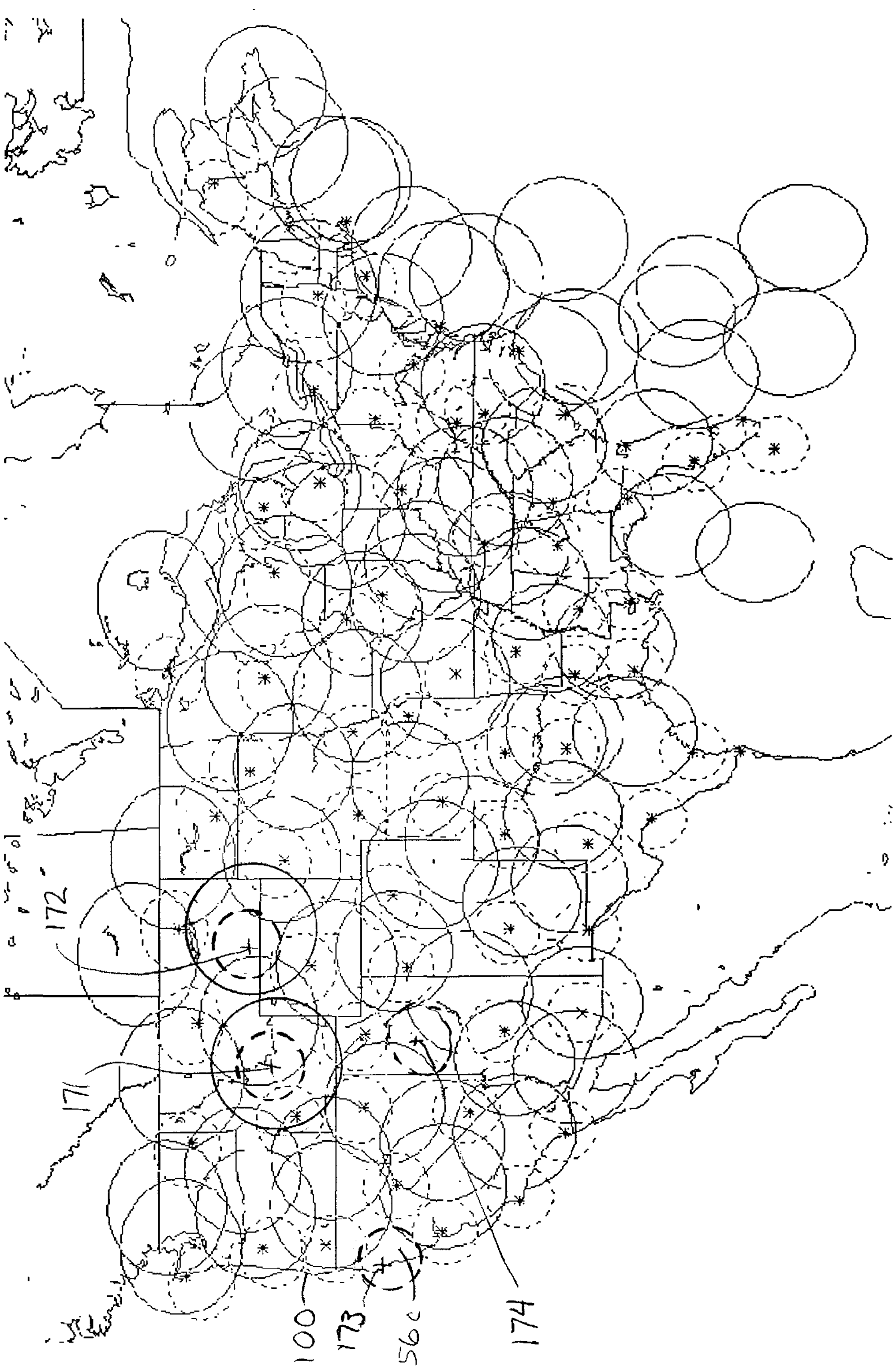


FIG. 9

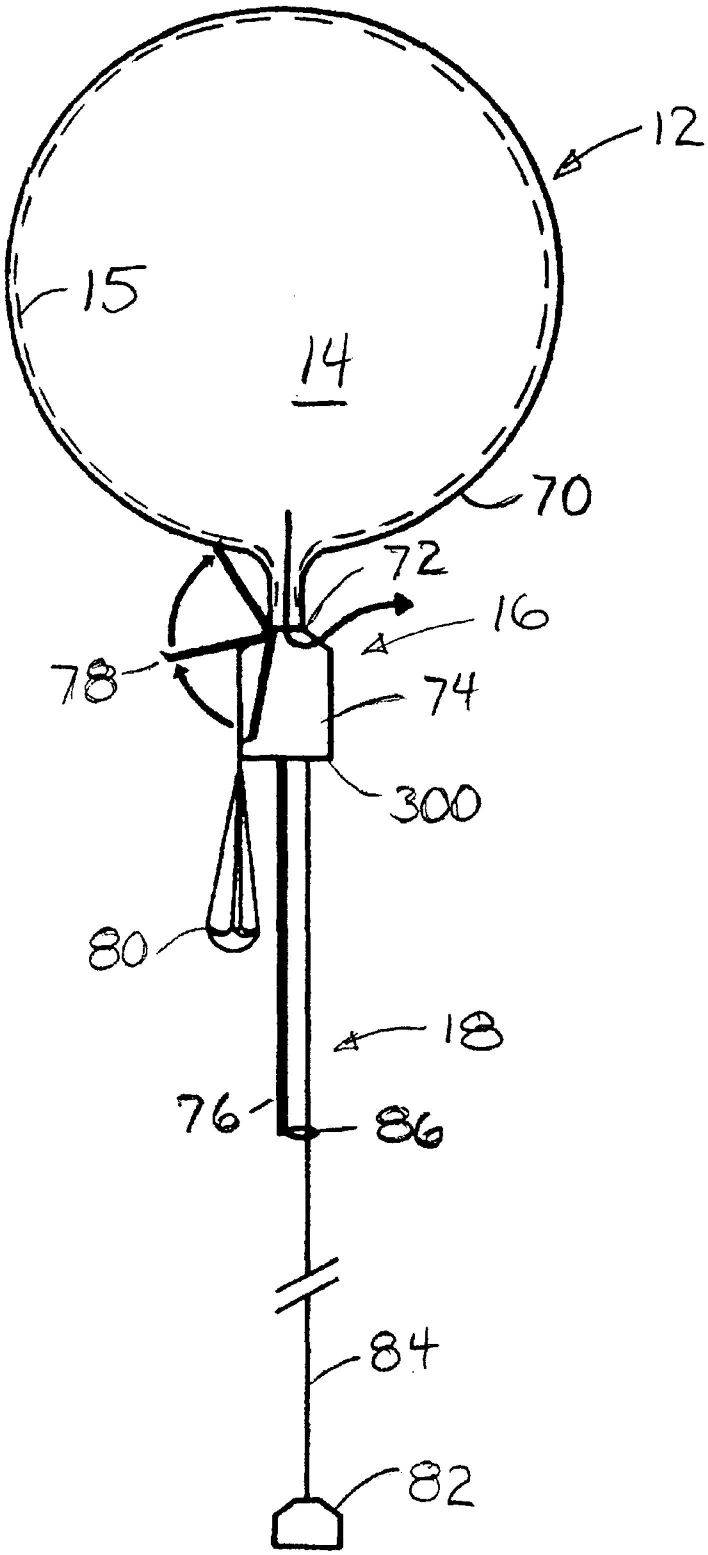


FIG. 10

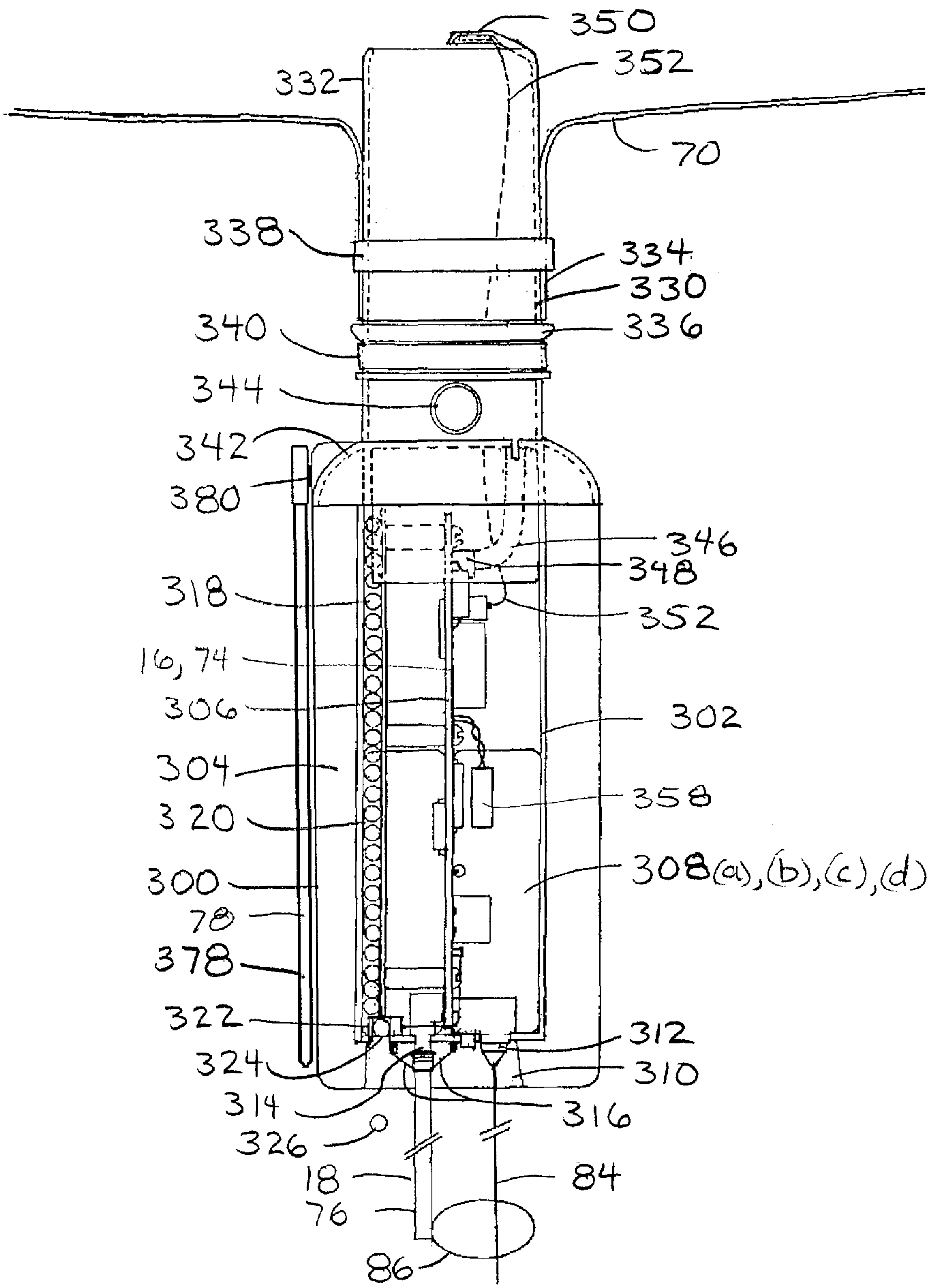
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FIG. 11

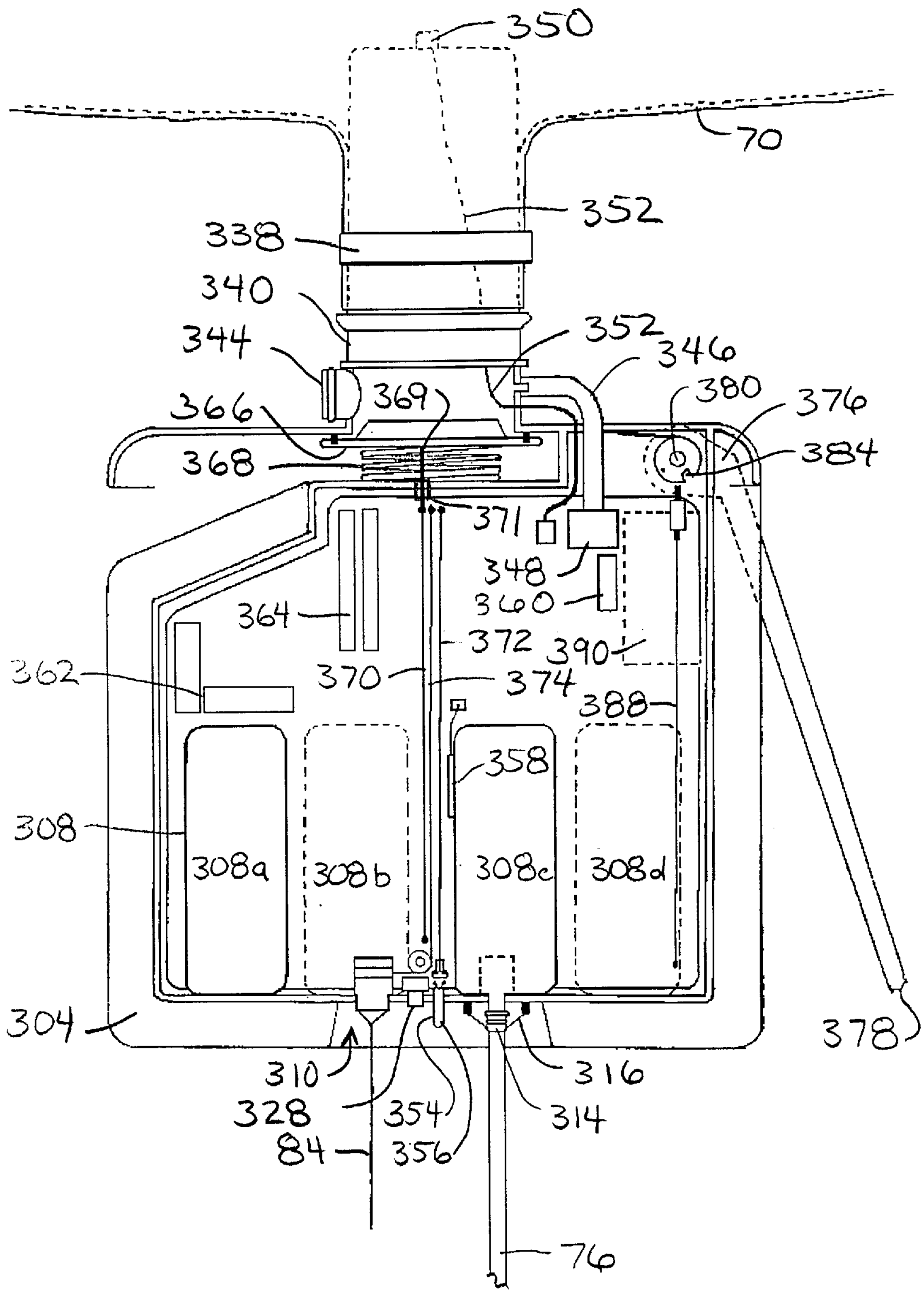
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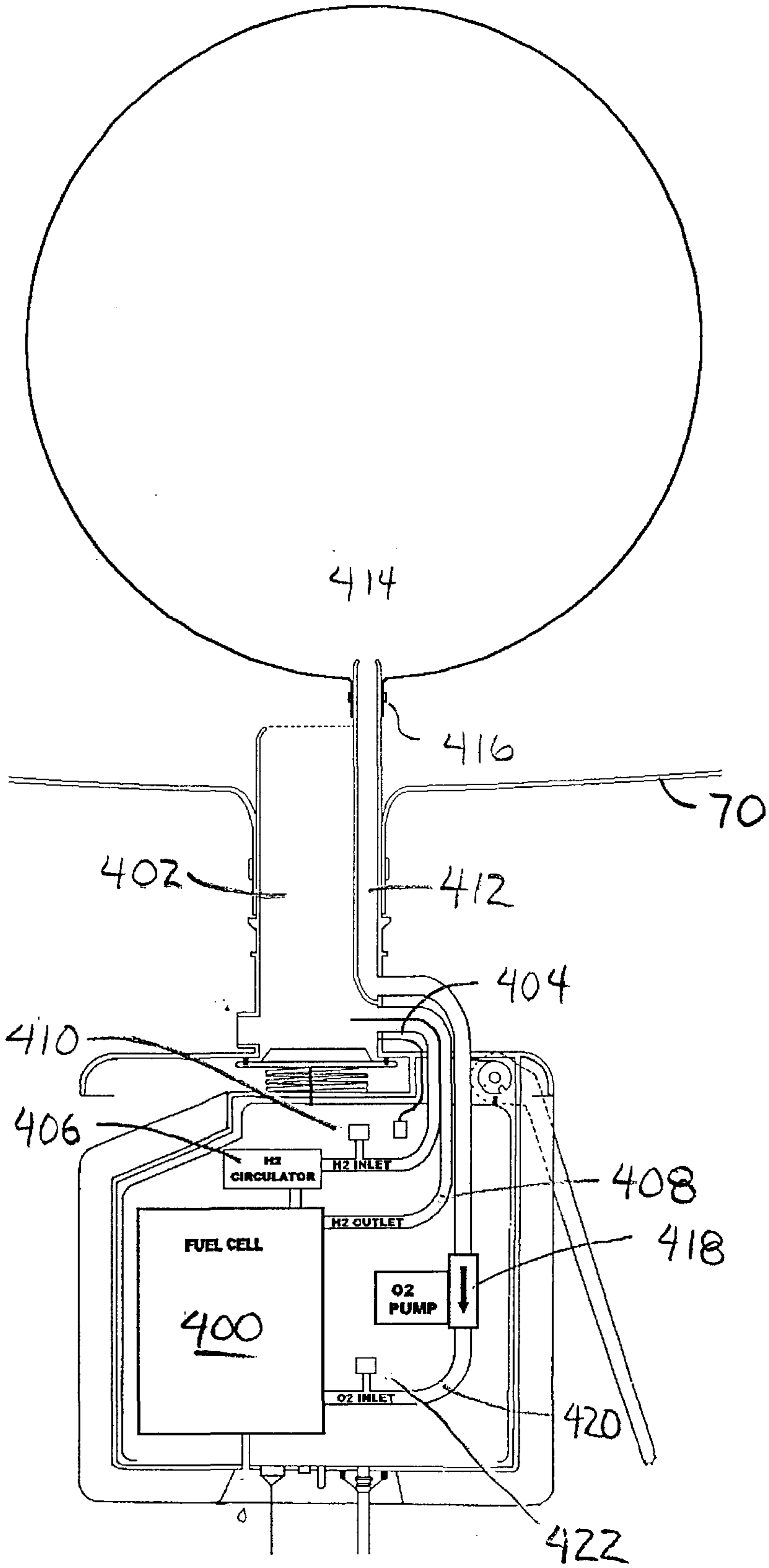
FIG. 12



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402
412
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406
H2 CIRCULATOR
H2 INLET
H2 OUTLET
408
418
FUEL CELL
400
O2 PUMP
O2 INLET
420
422


FIG. 13

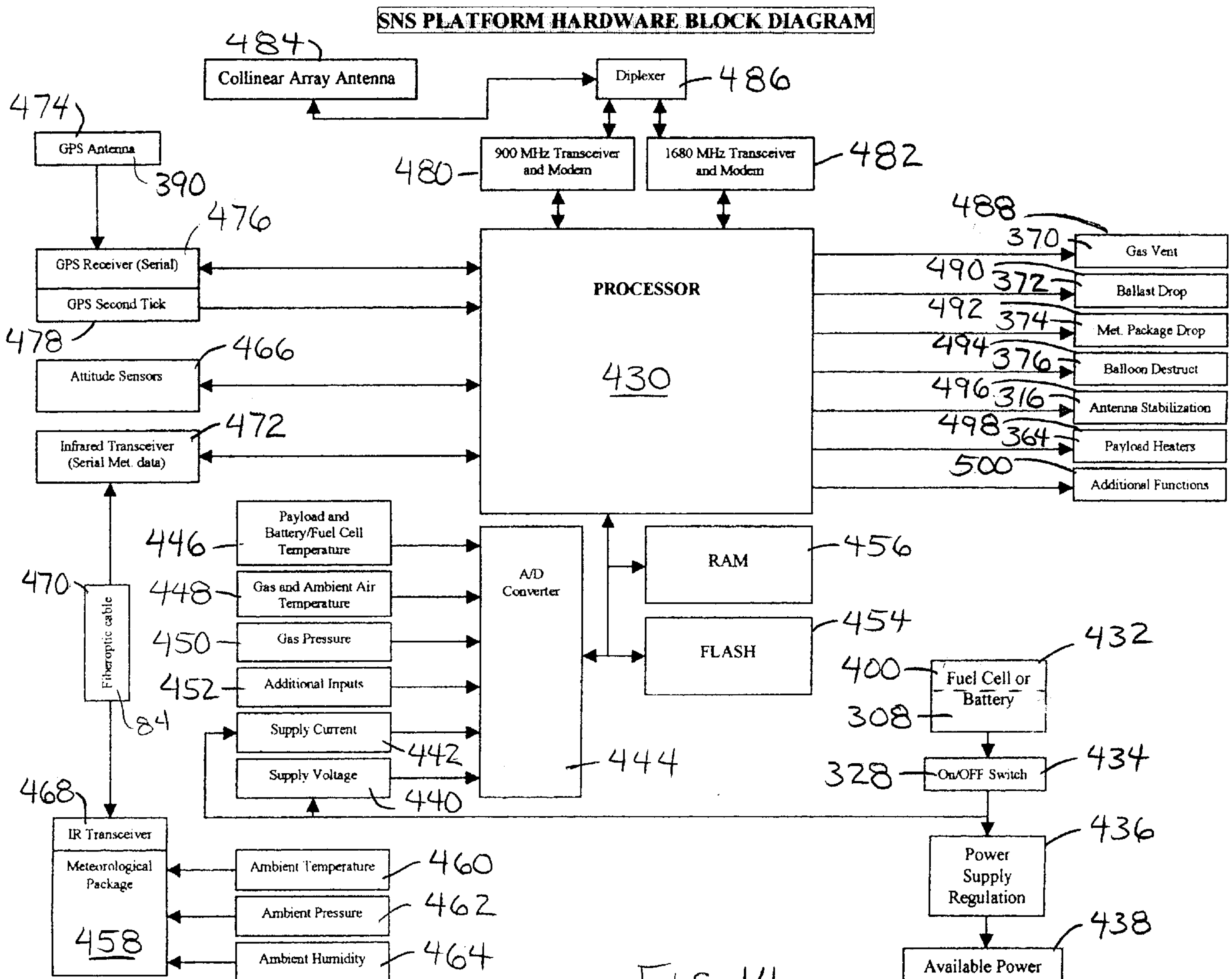
SNS PLATFORM HARDWARE BLOCK DIAGRAM
484
Collinear Array Antenna
Diplexer
486
474
GPS Antenna
390
480
900 MHz Transceiver and Modem
1680 MHz Transceiver and Modem
482
476
GPS Receiver (Serial)
GPS Second Tick
478
PROCESSOR
430
488
370
Gas Vent
490
372
Ballast Drop
492
374
Met. Package Drop
494
376
Balloon Destruct
496
316
Antenna Stabilization
498
364
Payload Heaters
500
Additional Functions
466
Attitude Sensors
472
Infrared Transceiver (Serial Met. data)
446
Payload and Battery/Fuel Cell Temperature
448
Gas and Ambient Air Temperature
450
Gas Pressure
452
Additional Inputs
Supply Current
442
Supply Voltage
440
A/D Converter
444
RAM
456
FLASH
454
470
Fiberoptic cable
84
432
400
Fuel Cell or Battery
308
328
On/OFF Switch
434
436
Power Supply Regulation
438
Available Power
468
IR Transceiver
Meteorological Package
458
Ambient Temperature
460
Ambient Pressure
462
Ambient Humidity
464

FIG. 14

# AIRBORNE CONSTELLATION OF COMMUNICATIONS PLATFORMS AND METHOD

## TECHNICAL FIELD OF THE INVENTION

The present invention relates to a constellation of small, airborne communications platforms, and more particularly, to a plurality of small, lighter-than-air communications platforms spaced-apart and floating in the stratospheric layer of the Earth's atmosphere over a contiguous geographic area.

## BACKGROUND OF THE INVENTION

Until recently, all communications satellites were located on one orbit called the geosynchronous arc, which is located 22,300 miles above the Earth's equator. Since international treaties required satellites to be spaced two degrees apart, there were only 180 sites on geosynchronous orbit. An optimally-designed three-stage chemical rocket typically must be 94% propellant at launch to reach geosynchronous orbit, which, after allocating about 5.6% of the weight for the rocket, only leaves about 0.4% of the initial launch weight for the satellite. To put this in perspective, a typical 3,000 lb. automobile with the same performance would only be able to carry one 200 lb. person, would need a 8,400 gallon fuel tank, and would be junked after one trip! Finally, although the NASA space shuttle can service a few very low orbit satellites at great expense, most satellites cannot be serviced or upgraded after being launched.

Currently, since there are a limited number of sites on the geosynchronous orbit, geosynchronous satellites are growing in size and performance, now being able to broadcast television signals directly to homes. Recently, additional satellite networks have been deployed that do not require a geosynchronous orbit. All of these new networks have launched smaller communications satellites into much lower orbits where there are an unlimited number of sites. Because the satellites required for a network are more numerous and because the satellites are smaller, up to 8 satellites per rocket have been launched. Although satellites have become smaller and more numerous, there are still no "personal satellites" and no mass producers of consumer products in the satellite industry today.

It might be estimated that a network of microsatellites in low Earth orbit and ground equipment to accommodate the tracking, transmission, reception, signal handoff among the plurality of microsatellites and necessary system network for a voice system would cost at least $3 billion to deploy. Within four years of deploying a system, each one of five million subscribers might be expected to invest as much as $3,000 in the equipment, which results in a total combined investment by the users in the new equipment of about $15 billion. The cost of deploying a smaller system of low Earth orbit advanced messaging satellites might be estimated at about $475 million. Such a system might be expected to serve two to three million subscribers, each with user equipment costing $300–$ 1,000. Thus, the total investments by the users for their equipment may be at least $600 million.

There is currently an industry involving radiosondes for purposes of gathering weather information. Radiosondes are the instrument packages launched on weather balloons to gather weather data. Radiosondes are launched from a network of sites around the world at noon and at midnight Greenwich Mean Time each day. The weather service radio-



sondes collect temperature, humidity, pressure and wind data as they rise from the surface of the Earth to approximately 100,000 feet during a two-hour flight. This data is then input in atmospheric models that are run on supercomputers. The information gathered from the network of ascending radiosondes is critical in predicting the weather. Most countries of the world are bound by treaty to launch radiosondes from designated sites and to share the data with other countries. Currently there are about 800,000 radiosondes launched each year throughout the world. This number represents the 997 global weather stations launching two radiosondes per day, 365 days per year (727,000) plus a small number of radiosondes launched for military and research purposes. About 18% of radiosondes are recovered, reconditioned and reclaimed, resulting in new production of about 650,000 weather-gathering radiosondes per year.

The location systems currently used to track weather balloons are either being deactivated (Omega, beginning before the year 2000, and Loran-C, shortly after the year 2000) or are so old that the operation and maintenance is becoming prohibitively expensive (radars and radiotheodolites). Changes in radiosonde systems are usually very slow, since meteorologists study climatic trends by comparing data collected over decades. Thus, they are very leery of any changes that may introduce new biases into data as it is collected. This is evident from the fact that major users, like the U.S. National Weather Service (NWS) still use analogue radiosondes tracked by radiotheodolites when digital, navaid sondes have been around for many years. Tightening of governmental budgets have made some users unable to pay for new technology required. There presently is a push in the sonde marketplace to convert to using the Global Positioning System (GPS) for wind tracking on radiosondes. From 1995 to 1998, the NWS tried and failed to get the U.S. Congress to fund a program to develop a GPS tracking system for the U.S. Observation Network. This inability to obtain the necessary newer technology to replace old and unsupportable radiosonde infrastructure is occurring simultaneously with the reallocation of the radiosonde's RF spectrum to commercial uses. Radiosondes have traditionally transmitted at 400 MHZ for navaid sondes and 1680 MHZ for radiotheodolite sondes. The 400 MHZ band may be auctioned off by the Federal Communications Commission (FCC) in the United States for simultaneous use by commercial services. Thus, interference is increasing and sondes may be forced to use narrower bandwidths with digital downlinks instead of the wide bands with analogue downlinks still in common use.

Very large and expensive NASA balloons have been individually launched and maintained at a floating altitude for extended periods of time. These balloons carry hundreds of pounds of equipment and cost tens of thousands of dollars each. The single balloons do not have the capability of line-of-sight continuous coverage of extended geographic areas because of drifting.

Personal communications services (PCS) is a new category of digital services that the FCC started auctioning spectrum for in 1994. PCS is split into two categories: broad band and narrow band PCS. The broad band category is primarily for voice services and PCS broad band phones now compete with traditional cellular phones. The narrow band category is for advanced messaging, which is essentially two-way paging. The paging industry sees advanced messaging as being the mobile extension of one's e-mail account, just as a cellular phone has been the mobile extension of one's desktop phone. Nationwide narrow band PCS (NPCS) was the first spectrum ever auctioned by the

FCC. About 30 regional and nationwide NPCS licenses have been auctioned and sold to private commercial ventures. The fact that the spectrum was auctioned is significant in that there are fewer restrictions on the use of this spectrum than on the use of traditional spectrum licensed from the FCC. Before auctions, the FCC granted spectrum on a piecemeal basis, and companies had to prove that they were using the airwaves for the "public good." Usually there was very specific federal regulation on how the frequency could be used. Since companies paid for their PCS licenses, they essentially own the spectrum. The FCC imposed only minimal regulations to prevent systems from interfering with other carriers' and other countries' systems. Additionally, the FCC and Industry Canada reached what is known as a Terrestrial Radio Communication Agreement and Arrangement in which Canada allocated the same frequencies for NPCS with the same channel structure as the auctioned spectrum for the NPCS in the United States. This made cross-boarder NPCS possible and in 1996, at least one paging system company was granted an NPCS license in Canada to operate on the same frequencies as its U.S. licensee. Mexico also has specified the same channel spacing as used in the United States.

One of the goals of the FCC is to encourage providing radio frequency (RF) communications services to consumers in rural areas at an affordable price. This market has been largely ignored by the larger communications companies because of the diminishing return on investment in providing wireless communications to sparsely populated areas. These wireless services include paging, advanced messaging, telemetry, voice, etc. Although both voice and messaging services are available to rural areas using satellite systems, the costs are generally in the thousands of dollars per unit and well out of reach of most consumers. In addition satellite systems have problems providing services in urban areas because they lack the signal strength necessary for providing building penetration.

## OBJECTS AND ADVANTAGES OF THE INVENTION

The present invention overcomes drawbacks of prior communications satellites, by using small and relatively inexpensive microelectronics to incorporate most of the functions provided by existing communications satellites in small, lighter-than-air communications platforms. In particular, a plurality of lighter-than-air balloons forming a constellation are designed to carry microelectronic communications equipment into a layer of the Earth's atmosphere called the stratosphere. The weight of these platforms is approximately 100 to 1,000 times less than the micro-satellites currently launched into non-geosynchronous orbits. For convenient reference, the airborne communications platforms or balloons carrying a payload of electronic communications and control equipment have sometimes been referred to herein as "stratospheric nanosatellites" or "SNS" for short. In the metric system, the "nano" prefix signifies units 1,000 times smaller than the "micro" prefix. The SNS invention eliminates the need for a rocket to propel the satellite into orbit. Synchronized airborne launching of a plurality of the SNS platforms at spaced-apart geographical locations provides a low cost constellation of satellites. The SNS platforms rise after launch to a controlled, adjustable altitude where they migrate over the geographic area according to atmospheric and the stratospheric weather conditions and particularly the winds. The SNS platforms may be raised or lowered in altitude by gas venting or ballast drop in order to catch prevailing winds favorable to keep the SNS platforms evenly spaced apart. The platforms are caused to rapidly descend when no longer needed. Additional launches of additional platforms fill excessive gaps occurring in the constellation.

Existing user equipment designed for terrestrial wireless communications can work with the SNS system of the present invention. This is not the case in the traditional communications satellite industry, since either the communications satellites are very far from the user (more than 22,000 miles for geosynchronous satellites) making the signal too weak without specialized user equipment, or the satellites travel at high speeds relative to the users on the ground (more than about 36,000 mph for low earth orbit satellites) causing frequency errors in the receiver. The SNS platform is, at most, about 175 miles (280 kilometers) from the ground user, depending upon the altitude and the radial coverage range from the particular platform among the plurality of platforms covering the geographic area. Moreover, the airborne platforms move at speeds approximating the speed of an automobile (between about zero and 80 mph at their float altitude). Compatibility with existing wireless communications systems is a significant advantage because when deploying a new communications system, the user equipment investment is always the largest total investment required.

In contrast to the large deployment and new equipment costs for orbiting satellite systems, the present invention provides a low cost alternative that does not require new subscriber equipment. Thus, a benefit of the SNS System is an advanced messaging SNS network that is compatible with standard one-way and two-way pagers already in existence and already in use with tower-based transceiver networks. Even without considering deploying of the SNS system, market analysts predict 35 million users will be carrying compatible, standard two-way pager equipment by the year 2003. At, for example, $100/unit, this represents an investment by users of over $3.5 billion. These users can receive the enhanced coverage of the inventive SNS platform network as an extension of their present service simply by electing to pay the monthly and incremental usage fees. There are no up-front costs for new user equipment or training and no need to change the user's habits and burden them with carrying more than one pager or other communications device as is the case with current satellite pagers.

Furthermore, the inventive SNS system, when performing advanced messaging, uses a communications protocol or pager protocol that is being adopted internationally. International opportunities for the new system are at least equal to the U.S. potential. The SNS System may utilize other popular paging protocols as well. The system also has uses beyond personal paging for other communications, remote imaging, infrared scanning, equipment tracking and weather data collection services.

It will also be beneficial for the National Weather Service (NWS) to consider utilizing the current SNS invention as a replacement system capable of providing the NWS with required information during the ascent of SNS platforms. GPS information available from the SNS Platform could provide the desired wind information the NWS needs but is unable to afford. Existing NWS launching facilities might even be used as SNS launch, tracking and communications sites. After the ascent and transmission of weather data to the NWS, the platform would then be controlled to float at a regulated altitude and to provide other commercial communications services. The NWS sondes could be removably attached and dropped as ballast after the ascent is complete and the desired information therefrom has been transmitted

to the NWS. The attached radiosondes could use exactly the same sensors utilized in the current radiosondes in order to keep the data consistant with current radiosonde data.

The inventive SNS network is uniquely designed to cover large areas and to use dedicated frequencies on a national, and ideally, on an international basis, between bordering countries. It is beneficial to allocate nationwide, or ideally international dedicated frequencies to the SNS system due to the large coverage circles of each of the SNS airborne platforms. Overlapping use of the same frequency without time multiplexing the signals would most likely cause interference at the receiver. The System will optimally work within a range of frequencies designated the "Narrowband Personal Communications Services" or "NPCS" spectrum. Moreover, the NPCS industry in the U.S. has generally agreed on a standard two-way messaging protocol called "ReFLEX" (ReFLEX is a trademark of Motorola, Inc.). ReFLEX is a protocol that uses a Time Division Multiple Access (TDMA) system. The ReFLEX protocol is an extension of the FLEX protocol designed by Motorola and is a synchronous protocol where there are 128 frames in a four-minute cycle. The start of each frame is coordinated nationwide using GPS technology for timing. This will allow a single frequency to be shared between the SNS network of the present invention and existing terrestrial satellite networks by simply allocating a certain number of frames to each network during each four-minute cycle. Thus, the disclosed SNS system can either operate on its own dedicated frequencies or interoperate with terrestrial systems on the same channel and never transmit on top of each other. This is unique to TDMA and is preferably incorporated into the new SNS system.

While the TDMA system is used by the preferred FLEX and ReFLEX protocols, the SNS invention may also work using other systems such as Code Division Multiple Access (CDMA) and even Frequency Division Multiple Access (FDMA) systems. Code Division Multiple Access (CDMA) spreads the digitized data over an entire available bandwidth. Multiple data streams are laid over each other on the channel (sometimes referred to as spread spectrum technique), with each datastream assigned a unique sequence code. While the unique sequence code can provide a very efficient use of bandwidth, it nevertheless is highly complex and expensive. The FDMA system assigns each datastream its own frequency. Although this provides a system that is fairly easy to implement and has a low cost from an equipment standpoint, it nevertheless results in a highly inefficient use of bandwidth.

ReFLEX has 128 discreet time slots or frames in a four minute period. The SNS system may use its own frequencies or it may share the time slots with a partnering paging carrier. The TDMA system used by ReFLEX provides efficient use of bandwidth. It has some complexity and associated equipment cost. However, the complexity continues to be more easily handled with high speed microprocessors and the equipment cost continues to be reduced.

On one frequency, the 128 time slots or frames that the ReFLEX protocol breaks each four minute cycle into, can be shared by the SNS system with other paging antennas and terrestrial towers that may have overlapping geographic coverage. A single pager may be able to receive the broadcast from multiple platforms and terrestrial towers, but because each platform or tower with adjoining coverage is allotted a specific frame or specific frames, the pager "hears" only one transmitter in each time slot. It is an object of the present invention to provide a construction of communications platforms that may be dynamically assigned new frames in which to transmit as the platforms drift in order to make sure that a pager receives transmissions from only one transmitter in the same frame.



Also it is an object of the present invention that the time slots may be dynamically reassigned so that at any given time or location one platform may have a greater number of available time slots than another in order to provide more capacity to platforms that may need higher capacity. Dynamic frame allocation (or dynamic capacity allocation), is a complex task. At any time that more frames are allotted to one platform, all other platforms that have overlapping coverage with that one platform lose access to the frames that are assigned and therefore lose capacity. Nevertheless, the ability to have dynamic frame allocation will facilitate maximizing capacity of the entire system by efficiently using all available time slots to their greatest capacity while minimizing allocation of time slots or frames in geographic areas with low communications capacity requirements.

Also although the ReFLEX two-way paging protocol using TDMA as described above is preferred, it is also an object of the present invention that the SNS may also be compatible with other pager protocols. For example, three other primary pager protocols include FLEX, POCSAG, and ERMES. The FLEX protocol is the one-way paging system that is the predecessor of ReFLEX. POCSAG is an older paging standard for one-way communications and is less efficient. Nevertheless, most pagers in the U.S. are still POCSAG compatible even though FLEX has higher noise immunity, a higher throughput and is becoming the standard in the U.S. and abroad (except Europe) for one-way paging. The ERMES paging protocol is the one-way paging European standard (currently governmentally enforced). The SNS system could also be appropriately configured in its circuitry to handle communications according to the ERMES protocol and therefore is adaptable to European usage as well.

In contrast to most voice and paging networks where many different protocols are used over a wide range of frequencies, NPCS contains a near contiguous set of nationwide frequencies in which nationwide narrowband PCS licensees have adopted the FLEX/ReFLEX protocol.

The present inventive SNS system benefits from a nationwide consistency of frequencies and protocols so that it can relatively easily operate across all NPCS channels owned by any or all of the nationwide carriers if need be. Minimal governmental regulation of the NPCS bands also allow the new SNS system, which was unknown when the NPCS regulations were drafted, to operate in the NPCS bands without violating current regulations. Since the NPCS licensees essentially own the frequencies purchased at auction, and the inventive SNS system can compatibly use the same frequencies with permission from the purchaser, additional licenses from the FCC may not be needed. This unique feature also saves two or three years in start-up time that it can sometimes take in order to pursue separate licenses.

As discussed briefly above, in addition to minimizing the regulatory hurdles, the new SNS network has a huge advantage in that it does not require new, specialized user equipment. It is expected that there may be as many as between 6–15 million units of compatible user equipment operating off existing terrestrial networks. These can simply be added to the new SNS system using inexpensive system programming and thereby receive the expanded, more complete, coverage of the contiguous geographic area provided by the constellation of floating communications platforms according to the present invention. To the NPCS carrier, the new

system can provide complete communication coverage, particularly coverage in remote non-metropolitan areas.

Since existing paging equipment owners and users may acquire the expanded coverage provided by the present invention through their existing carrier, the decision to expand coverage can be as simple as checking a box on their monthly bill. They could keep their current paging company, and simply add the benefit of remote area coverage provided by the SNS. No new equipment is needed and no start-up time is needed to learn the features of a new electronic device. There is simply improved coverage for the user without changing equipment.

A very important benefit of the inventive SNS network is the significant improvement in complete remote area geographic coverage. Currently, wireless data coverage is a patchwork of covered high density population areas, primarily around metropolitan areas. The SNS network works cooperatively with the existing coverage areas and fills in all the low density population and thus low communication traffic areas all using the same subscriber device. The governmental regulations governing NPCS systems require minimum system build-outs for all licensees. For example, by about 1999, a nationwide licensee providing NPCS must service at least 37.5% of the U.S. population or 750,000 square kilometers, and by the year 2004, a NPCS licensee must service at least 75% of the U.S. population, or 1,500,000 square kilometers. Since the population is very concentrated, prior systems have been required to build towers for coverage over a very small percentage of the total landmass. In fact, the minimum area requirement for the 1999 and for the 2004 population service requirements correspond to approximately 8% and 16% of the total U.S. landmass, respectively, because of the high population density in U.S. cities. For example, covering 90% of the population requires a carrier to build out only about 20% of the country's total landmass. Servicing areas of low population density is more expensive for prior systems since tower transmitter/transceivers have a short range requiring much more equipment per potential customer. Thus, few prior carriers have systems that cover more than 90% of the population because of the diminishing returns. Many established wireless data carriers are built out only to about 70%–80%.

The present invention is designed to provide substantially 100% coverage and can be compatibly combined with existing wireless carrier systems and networks such that the high density build-out by prior paging system carriers handles the high population density geographic areas and the low population density or remote areas, wherever they might be located within the contiguous geographic area, are handled by the inventive SNS system. The SNS system is complementary to high density tower paging systems. Thus, although the SNS system has a lower total signal handling capacity when compared to high population density tower systems, it provides complete geographic coverage so that subscribers in or traveling through remote areas are provided with the additional coverage of the SNS system. Subscribers are always within the range of paging services or other compatible communications services using a single device. The SNS system may also reallocate capacity on a regional basis by launching more SNS platforms or by reallocating the frequency use dynamically among the neighboring platforms.

The SNS system also has uses beyond personal paging for other communications including voice, remote imaging, infrared scanning, equipment tracking and weather data collection services. Broadband PCS (BPCS) phones that have come to market in the past year all offer an advanced messaging service call Short Messaging Service (SMS). The SNS system could page a subscriber's phone when the phone was out of the BPCS phone service area. BPCS voice service may also be possible with an SNS system. Another potential application for SNS technology is the remote imaging market. Governments, city planners, farmers, environmentalists, mapmakers, and real estate developers all rely on aerial or satellite photos. Worldwide, this market is over $1.4 billion. Since an SNS is over twenty times closer to the subject than a satellite, SNS can achieve one-meter resolution with only a 0.75-inch diameter lens. Weather data from the extended stay in the stratosphere can be collected and reported by the SNS platform as current radiosondes do not have the capability of maintaining a float altitude.

## SUMMARY OF THE INVENTION

The preferred embodiment of the present invention is a constellation of small airborne communications platforms with a ground network of launching, tracking and communications terminals. Although the entire system is described primarily in terms of communications that are in the form of a paging system, other communications such as voice communications, emergency road service, search and rescue, emergency medical, remote imaging, environmental monitoring, industrial & utility monitoring, remote asset management, photo data, IR scanning, equipment tracking, boxcar and container tracking, vehicle security, personal security, hazardous materials, customs and international shipping security, child security, wildlife tracking, personal messaging, communications for the handicapped, SCADA, trucking communications and shipment tracking, and many other adapted communications might be easily included. As it is used here, paging includes traditional one-way paging as well as newer advanced messaging services (such as two-way paging and voice messaging). The airborne constellation of communications platforms and ground support system extends the limited coverage of current paging networks to provide complete communications coverage over an entire contiguous geographic area. For example, in the U.S., it provides true, nationwide coverage. The ground based tower systems already in place provide the in-building coverage needed in the urban areas while the SNS System provides coverage of the low population density, rural areas. Thus a subscriber can have complete nationwide coverage using the same handheld paging device. The inventive system does this by providing a constellation of evenly-spaced, high altitude, airborne communications platforms, for example, balloon-carried paging transceivers, as opposed to the traditional systems of ground-based communications towers covering only a limited area or, as opposed to very expensive orbiting, high or low altitude, satellite communications systems.

To form the constellation of airborne communications platforms, paging transceivers are attached to lighter-than-air carriers, such as high altitude balloons similar to those used by the National Weather Service (NWS) yet modified to provide for regulated adjustable altitude control using methods such as gas venting and ballast dropping. The lighter-than-air carrier or balloon and the attached communications devices have been referred to in this application as stratospheric nanosatellite platforms (SNS platforms). For coverage of a contiguous geographic area consisting of the continental United States, SNS platforms may be launched periodically at regular intervals or as needed from approximately 50 to 100 sites throughout the United States. These launch sites may be selected for launching the balloon-

carried transceiver to rise to a regulated floating stratospheric altitude of approximately 60,000 to 140,000 feet. Computer regulated altitude control and computerized tracking are utilized. The SNS platforms are regulated to maintain a desired altitude within a predetermined altitude range, as, for example, in the stratosphere over the Earth, as they drift along with existing wind currents. New SNS platforms may be launched to fill any gaps that may occur in the coverage as the platforms drift at different speeds, as they loose buoyancy or as they occasionally burst or malfunction. New SNS platforms may also be launched to provide additional communications capacity as the need arises. Newly launched SNS platforms can collect, record and transmit meteorological data during the ascent to the regulated altitude. Such data might be beneficially communicated via radio to the ground for use by the National Weather Service (NWS). The process of modeling and thereby predicting the coverage of the network of SNS platforms on a continuous basis is a complex task due to the constantly changing weather conditions. This task is facilitated by also using the weather data recorded and/or transmitted to the ground for predicting the movement of individual platforms relative to each other and relative to ground launching and tracking terminals. This data may also be used to control the altitude of individual SNS platforms to catch favorable prevailing winds to help fill gaps in coverage. Each floating satellite at a stratospheric altitude will have line-of-sight radio communication coverage at a radius of approximately 175 miles (280 km) in all directions from antenna suspended below and forming a part of the communications platform.

Ground-based support for the plurality of SNS platforms forming the constellation consists of at least one network operations center (NOC) and a plurality of launching and tracking terminals. The NOC is preferably a high speed, high volume, computing, communications and operations center for the SNS system. The NOC may be in charge of all controllable aspects of every communications SNS platform's flight and operation. These controls include platform launches, floating altitudes, tracking, all paging communications and control signal transmissions, and communications with partnering paging companies. Typically, the SNS ground terminals include launch facilities, tracking and communications equipment and communication antennas. The co-located launch facilities and ground terminals may also advantageously correspond with existing locations of the approximately seventy NWS balloon launch facilities that are designed to monitor weather conditions nationwide. Similar Weather stations also exist and are maintained by treaties essentially world wide. These ground terminals may be automated. Portable or mobile launching and tracking ground terminals can also be used when necessary to fill in anticipated coverage gaps that may develop between the overlapping circular coverage patterns of the floating platforms. These portable or mobile launching and tracking ground terminals may be moved seasonally to provide additional launch sites as the stratospheric winds change on a seasonal basis. These would most likely be positioned along the coastline or the edges of the coverage area. The ground terminals can advantageously track a number of SNS platforms floating near their location and can provide the uplink and downlink of all communications, including paging and control data, to each platform within range of the terminal. Paging signals from a subscribing paging company may be sent to the SNS system through the NOC. The NOC determines which SNS platform is currently over the addressed pager and sends the paging message to the ground terminal that is tracking that SNS platform. The ground terminal receives the paging message from the NOC and relays it to the SNS platform. The SNS platform then transmits the paging message down to the individual pager. Any message sent by a two-way pager is received by the nearest SNS platform and relayed down to the ground terminal. The ground terminal sends the message to the NOC, which relays the message to the appropriate subscribing paging carrier. The NOC also keeps track of all billing information and subscriber location information. The SNS system is advantageously designed to be fully compatible with FLEX (one-way pagers) and also ReFLEX (two-way pagers) without modification to the pagers. The launch facilities, whether co-located with NWS launch facilities or separately located at other selected ground locations, may consist of a fully automated launcher and ground terminal. One ground terminal may control multiple SNS platforms at one time. Land lines, satellite links, platform-to-platform, balloon-to-balloon, or other network communications coupling from one ground location to another may be used to connect the plurality of launch sites and ground terminals to each other or the NOC.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the invention will be more fully understood with reference to the following specifications, claims and figures in which like numerals represent like elements and in which:

FIG. **1** is a schematic depiction of a plurality of airborne platforms representing a constellation of platforms over a contiguous geographic area, launch facilities and communications terminals, networked together with a network operations center through ground lines and, alternatively, through orbiting satellite communications signals;

FIG. **2** is an enlarged depiction of a plurality of airborne platforms, a single moveable launch site and ground terminal with network linkage to a network operation center for a plurality of ground terminals and personal communications devices;

FIG. **3** is a schematic depiction of platform-to-ground terminal communications being handed off from one ground terminal to a next ground terminal;

FIG. **4** is a schematic depiction of inter-platform communications with subsequent transmission to ground terminals and to a network operation center (NOC);

FIG. **5** is a schematic depiction of platform-to-space satellite communications links for providing the network interconnection with a network operation center (NOC);

FIG. **6** is a schematic depiction of a "hub and spoke" network communication link topography;

FIG. **7** is a schematic depiction of a mesh network communication link topography;

FIG. **8** is a schematic depiction of a contiguous geographic area, particularly the United States, with airborne SNS platform launch sites and showing initial coverage area SAS circles, superimposed on a map of the geographical area and demonstrating the line-of-site coverage areas for each SNS platform such that substantially the entire geographic area is encompassed within the reception range of one or more of the airborne platforms;

FIG. **9** is a schematic depiction of an example of airborne platform migration after a period of regulated altitude free-floating of the airborne platforms and also depicting additional gap-filling launch sites, that may be provided by mobile launchers, to supplement and complete the continuity of coverage with additionally launched airborne communications platforms;

FIG. **10** is a schematic side view of an airborne platform in which a lighter-than-air gas enclosure, such as a balloon, is attached to a box holding the electronic controls, communications devices, sensors and a meteorological data gathering package;

FIG. **11** is an enlarged partial cross-section of an airborne platform, including the control and communications box fastened to a lighter-than-air gas enclosure, or balloon, according to one embodiment of the present invention;

FIG. **12** is a side partial cross-sectional view of the airborne control and communications platform of FIG. **11** according to one embodiment of the invention;

FIG. **13** is a partial cross-sectional side view of an alternative embodiment of a control and communications platform in which an alternate power source, including a hydrogen/oxygen-powered fuel cell is used in place of the batteries of the embodiment of FIG. **12**; and

FIG. **14** is a schematic block diagram of an electronic circuit for control, sensing, and communications according to one embodiment of the invention.

## DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** depicts a schematic view of a portion of a constellation and communications network system **10** according to the present invention in which airborne platforms **12**(*a*)–(*g*) have reached a desired altitude within a range of altitudes, such as in the stratosphere. Also depicted is an airborne platform **12**(*h*) in the process of ascending to a desired altitude. Each airborne platform comprises a lighter-than-air gas enclosure **14**(*a*)–(*h*), a platform control and communicator device **16**(*a*)–(*b*) and an antennae **18**(*a*)–(*b*). Communication signals between platforms and ground terminals are schematically represented at **20**(*a*)–(*u*) correspondingly communicating with a plurality of ground communication devices such as radio signal receivers, transceivers, transmitters, or pagers **22**(*a*)–(*u*). There are a plurality of launch and tracking terminals **24**(*a*)–(*d*), each having a plurality of tracking antennas **26**(*a*)–(*g*). Ground terminals relay message and control data between the SNS platforms and the NOC. Preferably the ground terminals can operate unattended requiring only electrical power and communications signals. The ground terminals consist of a set of transmitters and receivers and their controller, tracking antennas and a tracking controller, redundant communications links to the NOC, and backup power supply. To accommodate the potentiality for several platforms within range at any given time four to six separate transmitters, receivers and tracking antennas are currently contemplated. Glenayre offers appropriate commercially available transmitters, transmitter controllers and receivers for the SNS ground terminals although some modifications will be required. The tracking antennas **26** are schematically shown in communication with the various platforms through signals **28**(*a*)–(*g*). A ground communication network **30**, having interconnecting segments **30**(*a*)–(*d*) are depicted communicating between the launch and tracking stations **24**(*a*)–(*d*) and a network operations center **40**. The network operations center **40** may also communicate with a plurality of launch and tracking terminals **24** through an orbiting satellite **32** and launch site satellite antennas **38**(*a*)–(*b*) and network operation center satellite antenna **42**. For purposes of illustration, launch and tracking terminal **24**(*c*) is co-located with an airborne platform launcher **44** similar to or the same as the National Weather Service balloon launcher. One aspect of the invention also contemplates a mobile launcher and tracking terminal **46**, as for example a self-contained unit mounted on a truck trailer. The mobile launcher can be transported to a desired launch site, parked there and additional SNS platforms can be launched. The tracking and communications terminals **24** can be connected to the network via ground links **30**(*c*) and **30**(*d*), as well as to other launch stations and to the network operations center **40**. The mobile launcher and terminal may be moved periodically from one location to another location to launch and/or track additional SNS communications platforms **12** as needed to fill in coverage gaps as they might arise due to weather conditions.

FIG. **2** is an enlarged schematic depiction of the mobile SNS launcher **46** of FIG. **1** shown schematically in relationship to platforms **12**(*f*), **12**(*g*) and **12**(*e*) that form a portion of the constellation of platforms. The mobile SNS launcher is in communication with the network operations center **40**. Further depicted in FIG. **2** is a range of desired altitudes **50** defined by a minimum desired altitude **48** and a maximum desired altitude **52**, each altitude measured relative to sea level **54**. In one preferred embodiment, a predetermined range of altitudes is defined by a minimum desired altitude of about 60,000 ft. and a maximum desired altitude of about 140,000 ft. These altitudes generally correspond to the Earth's stratosphere or to a range of stratospheric altitudes **50**. Further depicted in FIG. **2** is a gap of coverage **56** between spaced-apart platforms **12**(*g*) and **12**(*e*) schematically represented as a spaced-apart distance **56** that is significantly larger than the desired spaced-apart distance **58** between platforms **12**(*f*) and **12**(*g*). In a further preferred embodiment, it is anticipated that platforms will be regulated to float within a predetermined altitude range of between about 70,000 ft. and 100,000 ft., will have a coverage radius measuring about 175 miles (280 km), will be above commercially regulated airspace and will be below altitudes at which platform survival is less certain. When the distance between two adjacent platforms in any direction is greater than about one and one-half times the coverage radius, a gap in coverage can begin to occur. In such instances, either an additional SNS platform can be launched from a fixed launch site or a mobile launching unit **46** can be moved on the ground to a location substantially between the two spaced-apart platforms **12**(*g*) and **12**(*e*) so that an additional supplemental platform **12**(*h*) may be launched for rapid ascent to the desired altitude range **50**. Computer modeling based upon the tracking of all the platforms **12** in a constellation **10** of airborne platforms can be used to predict the development of significant gaps **56** in coverage and to rapidly deploy mobile launching units to fill the gaps. In the event that a stationary launching and tracking terminal is already in a location for launching a supplemental SNS platform, no mobile unit would be required.

FIG. **3** schematically depicts a platform **12**(*i*) migrating due to wind currents to a handoff position **12**(*ii*) shown in dashed lines. At the handoff position, the next downwind ground terminal **24**(*e*) takes over tracking and communication and maintains control as the platform moves through position **12**(*iii*) and over terminal **24**(*e*).

FIG. **4** is a schematic depiction of inter-platform communications with subsequent transmission to ground terminals and to a network operation center (NOC).

FIG. **5** is a schematic depiction of platform-to-space satellite communications links for providing the network interconnection with a network operation center (NOC). This is advantageous because this can reduce or eliminate the number of ground terminals, as the platforms would directly communicate with the NOC through satellite links.

FIG. **6** is a schematic depiction of a "hub and spoke" network communications link topology. This is advantageous because it requires fewer physical communications lines and generally requires less expensive equipment than alternative network topologies.

FIG. **7** is a schematic depiction of a mesh network communications link topology. This is advantageous because a "mesh" topology provides multiple redundant communications links to other parts of the network adding increased reliability.

FIG. **8** schematically depicts a contiguous geographic area **100**, and in particular by way of example, a geographic area corresponding to the United States of America. Superimposed on the geographic area **100** are 70 selected standard launch sites represented by "Xs" **101–105** (only a few examples are numbered). Further schematically depicted are coverage areas **201–205** (again only examples are numbered) representing the position and coverage of each of the platforms **101–105** as they reach a desired regulated altitude, preferably in the stratosphere. Each platform is very small compared to existing geosynchronous orbit satellites such that they have been referred to and are designed to float in a regulated altitude in the stratosphere such that they have been designated as "stratospheric nanosatellites" (SNS). The coverage areas **201–205** are depicted in FIG. **4** assuming a relatively vertical ascent from the launch sites **101–105**. The coverage areas **201–205** will migrate over a period of time, due to wind and weather conditions in a particular locality. However, the ascent to the stratospheric desired altitudes normally takes from about one to two hours, such that the drift for normal airspeeds of less than about 10–20 mph and even passing through the jet stream if present will produce relatively small drifts of 10–80 miles in any direction during the ascent. Thus, relative to the approximately 175-mile (280 km), coverage radius for a circular coverage area having a diameter of about 350 miles (560 km), the migration during a short period of time with standard wind conditions of 10–40 miles, indicates that the launch site is a reasonable approximation for the initial high altitude location at the end of the ascent.

The platforms or balloons **12** are provided with altitude control mechanisms, including both low density gas venting and high density ballast dropping mechanisms, allowing the balloon to be controlled to maintain a desired altitude within a range of desired altitudes. The altitudes may be maintained for between 12–24 hours corresponding to the current NWS balloon launching schedule of two launches per day. If the NWS launching schedule is not used, the balloon altitudes may be maintained for over 100 hours depending on the lift gas, power, and ballast remaining on the balloon **12**. In the case of NWS balloons, currently the balloons self-destruct from overexpansion as they reach and exceed altitudes of over 100,000 ft. and weather data is gathered and transmitted to the ground during the ascent. In the case of balloons acting as carriers for the communications platforms, the platforms will be maintained at an altitude preferably less than 140,000 ft. And more preferably less than about 100,000 ft. and will continue to migrate due to upper stratospheric wind conditions. The NOC may command SNS platforms to rapid deflate or burst in the case of a balloon **12**, when the platform is no longer needed, it falls below the 60,000 ft. and no ballast remains, it drifts over an undesired area, or it malfunctions. The platform may initiate this if any of these conditions are met and the platform has lost communication with the ground terminals. Advantageously, the wind conditions will have been detected during the ascent and will continue to be monitored through the tracking by the ground stations. This will facilitate predicting the development of any gaps in coverage that might be expected, and particularly the location of such gaps and the number of ground communication devices or pagers that might need to be serviced in the area of the gap.



FIG. **9** is a schematic depiction of the geographic area **100** after a given migration time period during which significant gaps may begin to occur. Mobile units may be positioned at temporary launch sites **171** and **172** for filling developing gaps **56**(*b*) and **56**(*c*). Also, where a gap is predicted to develop in close proximity to a standard launch site, as, for example, at **105**, an additional platform may be launched from launch site **105** in advance of the normally regular launch time period. Thus, gap **56**(*c*) may be filled by an additional launch. In a similar manner, regionally located mobile launch sites may be employed to fill gaps as they arise. In the event that a pattern of gap development is detected, then additional permanent launch sites **173** and **174** may be added to help compensate for repeated developments of gaps **56**(*d*) and **56**(*e*), for example. Temporary launch sites may be moved seasonally to fill the gaps along the coast line along the direction the wind is blowing for the season, for example, the western coast during the winter season.

FIG. **10** shows a schematic side elevation view of a platform **12** in an embodiment in which the low density gas enclosure **70** is preferably a latex balloon **70**. A Totex 1000 balloon filled with hydrogen, helium, natural gas, or another suitable low density gas or mixture and internally coated to reduce gas diffusion adequately provides lift for the SNS communications platform. The Totex balloon is released with a diameter of about five and one quarter feet and expands to about twenty-four feet across at 140,000 feet altitude. It will be noted that other lighter-than-air enclosures, such as blimps, aerostats, zeppelins, airships, dirigibles, weather balloons, jimspheres, hot air balloons, sounding balloons or meteorological balloon might also be used in place of the proposed latex weather balloon **70** schematically depicted in FIG. **10**. Also, the diameter of balloon **70** in FIG. **10** is not to scale and it is expected that a total platform weight, including the payload box **300**, altitude control vent mechanism **72**, meteorological package **82**, antennae **76** and meteorological cable connection **84**. Preferably the cable **84** is a fiberoptic cable having a length of approximately 25 meters so that the meteorological data collection package **82** is sufficiently distanced from the balloon **70** to reduce to a minimum the effect of turbulence caused by the balloon on the meteorological data sensed by the meteorological package **82**. The fiberoptic cable **84** is used to transmit the meteorological data from meteorological package **82** to the communications unit **74**. Fiberoptic cable is used as wire could arc due to the high electric field potential when passing through thunderclouds.

There are numerous types of low density gas enclosure devices, and particularly balloons, that might be considered useful for the present invention. Among the potentially preferred types of balloons are rubber pressure balloons, zero pressure balloons, internal air bladder balloons, adjustable volume balloons and super pressure balloons. Each type of these balloons has different advantages and disadvantages and, for purposes of the present invention, it has been found that the rubber pressure balloon is most preferred and the zero pressure balloon is also considered a preferred alternative. Advantageously, such balloons **14** may be coated on a surface, preferably on the inside thereof as depicted schematically at **15** in FIG. **10**, with a reduced permeability material, such as by fluid deposition of a sealer that remains flexible upon application.

The rubber pressure balloons have a stretchable rubber membrane containing the lifting gas that allows the balloon to increase in size as the external air pressure decreases as the balloon rises. This is the most common type of weather balloon and is also consistent with party balloons. The primary advantage is the low cost and common accessibility so that high quality balloons of this type, such as weather balloons, are available at low cost. These balloons are somewhat fragile and they have delicate handling requirements and also low extended reliability. Further, the use of such balloons requires venting of the lifting gas to prevent bursting upon reaching maximum volumes.

The zero pressure balloons consist of an initially loose bag, usually made from a plastic such as polyethylene or Mylar. As the external air pressure decreases, the bag increases in volume. Once the bag reaches its whole volume, gas must be vented or the balloon will burst as the bag material does not stretch. Although this type of balloon may be more reliable than the rubber balloons and provide less diffusion of the lifting gas, it is of a median cost, more costly than the rubber balloons, currently between about four to ten times more expensive. Thus, although the rubber balloon might be more preferred for purposes of low cost platforms, the zero pressure balloon also provides a useful enclosure for lifting the platform up and has certain advantages over the rubber pressure balloons.

Internal air bladder balloons consist of a flexible balloon containing air enclosed in a fixed volume balloon containing a lifting gas. Air is pumped into the inner-flexible balloon which compresses the lifting gas trapped in the fixed volume balloon, thereby decreasing the overall lift. Air is let out of the inner-flexible balloon to increase lift. Blimps adjust lift using this principle. This type of balloon has certain advantages as there is no lift gas lost when reducing lift and it is potentially more reliable than rubber balloons, however it is more costly due to extra balloon, pump and extra required power for operating the increase and decrease of lift mechanism.

Adjustable volume balloons consist of a fixed volume containing the lifting gas and a mechanical way of reducing the volume of the balloon. By decreasing the volume, the lifting gas is compressed and the lift decreases. The volume may be reduced any number of ways, including an adjustable line inside the balloon from the neck of the balloon to the top of the balloon. When the line is shortened, volume decreases. The lifting gas is not vented to reduce lift and it may be more reliable than rubber balloons. However, it has a significantly more costly due to the mechanical volume reducing mechanism and further, requires extra power for operation of such a mechanical volume-reducing mechanism.

Super pressure balloons have a fixed volume. They are called super pressure balloons because they do not expand to match the decreasing exterior pressure. They are built strong enough to hold the increased pressure. The balloons can achieve extremely long float lives because they do not need to vent gas to prevent bursting and they typically have very low membrane gas diffusion. This type of balloon is the highest cost, although one of the most reliable, with little loss of lifting gas. The extreme high cost and difficulty of manufacture and the lack of developed technology regarding such balloons, indicates that other alternatives are currently more attractive.

A signal transmission antenna **76** extends from the communications device **74** preferably vertically downward from the communications device **74** and preferably a collinear array with approximately a 6 degree downtilt configured to provide even transmission and reception coverage over the entire circular coverage area. The antennae **77** may advantageously be provided with a support loop **86** to facilitate stabilization between the antennae and the meteorological connection cable **84**. Also depicted in FIG. **10** is a balloon destruct mechanism **78** and a parachute **80** for recovery of the communications device **74**, when the balloon is destroyed by the controlled destruct mechanism **78** or otherwise by natural causes.

FIG. **11** depicts a partial cross-sectional front view of one embodiment of a communications device **74** according to the present invention. There is a payload box **300**, including an interior container **302** and exterior Styrofoam insulation **304** surrounding the interior container **302**. Within the container **302** is a circuit board **306** to which various electronic components are attached and interconnected to provide signal communication and remote control of the platform as desired. The electronics section consist of the RF section, antennas, GPS receiver, processor and power regulators. The RF section is based on the low cost transmitter and receiver section of current two-way pagers. The transmitter power is increased to approximately 7 watts. A single 900 MHZ collinear dipole array antenna serves both for transmit and receive functions. Additional antennas may be added for gateway RF links to the Ground Terminals if the additional frequencies become available. Possible frequencies include the 400 MHZ or the 1680 MHZ band assigned to meteorological instruments. If the SNS system also collects weather data for the NWS and this data is transmitted on the meteorological aids band, it may be possible to send additional gateway traffic with the meteorological data. A twelve channel GPS receiver in conjunction with the processor provides positional information to both the NWS during ascent and to the SNS NOC for the entire flight. The NOC uses the information to locate the SNS platforms, to determine coverage holes or gaps, and to make rudimentary position adjustments by varying the altitude into favorable wind speeds and directions.

The embodiment depicted in FIG. **11** and the side partial cross-section thereof as depicted in FIG. **12** shows the power for the communications device **74** being provided by a plurality of lightweight, high power batteries **308**(*a*), (*b*), (*c*) and (*d*). The platform may require between about three and eighteen watts of power depending on the message traffic and the platform configuration. Lithium sulfur dioxide (LiSO2) batteries are cost and weight effective and have decent operating characteristics in a low temperature environment as found at high altitudes. The batteries are positioned at spaced-apart alternating positions so that maximum unit volume density is maintained below established maximum unit volume density requirements for federal aviation safety standards. The low unit volume density and low total payload weight keeps the launching of the balloons from being restricted by FAA regulations. For example, to facilitate keeping the platform safe as it ascends, A floating constellation communications system as in claim **1** wherein said each of the platforms will preferably be an unmanned free balloon and the payload box and its contents will preferably have a total weight of six pounds or less. The exterior surfaces will have predetermined areas and the weight to size ratio will desirably be maintained at no more than three ounces per square inch on any surface of the payload box and on the meteorological package where one is attached to the platform. The weight to size ratio is determined by dividing the total weight in ounces of any payload or package attached to the free balloon by the area

in square inches of its smallest exterior surface of such payload or package.

In the platform payload box **300** there is a bottom opening **310** through which the meteorological connection cable **84** connects at a releasable cable connector **312** to the circuit board **306** inside of the container **302**. Also, antennae **76** is attached at an antennae connection **314** located in the bottom opening **310** so that signals may be received or transmitted through the antennae **76** to and from circuit board **306**. Meteorological data from fiberoptic cable **84** may be received and processed in components of the circuit board **306** and transmitted to the ground terminal **24** through antennae **76**. To facilitate ease of detachment of the meteorological package upon inadvertent impact, the fiber optic cable will desirably separate from the balloon upon an impact of fifty pounds or less. Active antennae stabilizers **316** are provided to reduce and dampen movement of antennae **76** so that consistent signal reception and transmission is accomplished. To facilitate regulation of the altitude of the airborne platform **12** and the attached communications unit **74**, the payload box **300** includes a ballast storage chamber **320** in which ballast **318** is carried. Ballast **318** is preferably easily moveable lead shot, metal BBs or spherical glass beads that may be controllably released as with a ballast drop gate, such as a shuttle, that moves alternatively between opening into the ballast chamber **320** and then to the ballast outlet orifice **324**, such that the ballast may fall from the bottom opening **310** as schematically depicted at **326**. For convenience and for avoiding power depletion during storage or transport, a manual circuit activation switch **328** is provided.

At the top of the payload box **300** is a balloon connection spindle **330**, having a distal neck top **332** over which the flexible balloon connection neck **334** is attached. The balloon connection neck is sized for fitting over the spindle and is stretched and moved down to a stop lip **336** so that it is secured in position with one or more heavy rubber bands **338**. For convenience, a rubber band storage channel **340** is provided below the stop lip. A rubber band is stored and in position for securing a "fresh," lighter-than-air enclosure or balloon **70**. Preferably, balloon **70** will be filled with helium (He), hydrogen ($H_2$) or natural gas through a light gas fill valve **344** that is preferably positioned above a rain hood **342** that shields the payload box and certain components thereof from rain and other precipitation. The light gas fill valve **344** provides for a convenient connection to a light gas supply tank, such as a helium or a hydrogen supply tank, so that an expandable balloon is attached at its neck **334** to the spindle **330** and fill gas can then be supplied in a desired amount into the attached enclosure or balloon. A gas pressure sensor tube **346** communicates between the interior of the spindle to relay the internal balloon gas pressure sensor **348** connected to the electronics of the circuit board. A gas temperature sensor **350** is attached and is desirably positioned at or above the neck top **332**. A temperature sensor wire **352** communicates a signal representing the temperature to appropriate circuitry on the circuit board **306**. An ambient air temperature sensor **354** is also desirably provided, as well as an ambient air pressure sensor **356**, both of which are connected for communicating the sensed ambient air temperature and the sensed ambient air pressure to the circuit board. A battery temperature sensor **358**, a payload temperature sensor **360** and an attitude sensor **362** may all be connected to the circuit board **306** to desirably provide information and input for remote controlling and for maintaining the functions of the airborne platform **12** using the circuit **306**. The data collected from the gas temperature sensor **350**, the



ambient air temperature sensor **354**, the gas pressure sensor tube input **348**, and the ambient air pressure sensor **356** is used, in part, to determine if the balloon is nearing a burst condition. A heater and cooler device **364** is attached to control the interior temperature of the payload box. As the airborne platform ascends into high altitudes, the ambient temperature drops dramatically and the interior of the box will desirably be heated by heat generated by the batteries or, alternatively, by the heater **364**. If the heat from the batteries is significant and is combined with, for example, bright sunlight, the interior temperature might increase above desired operating temperatures, then the cooler portion of heater and cooler device **364** may be activated to maintain a desired operating temperature range. The heater and cooler device may be a thermoelectric cell.

For purposes of regulating the altitude of the balloon and, in particular, to avoid continuous ascent above the desired maximum high altitude, a light gas relief valve **366** is provided. A spring **368** keeps the relief valve **366** normally closed. An actuator rod **369** is attached to the valve **366** and to a valve actuator wire **370**, to open the valve against the spring loading. A Nickel-Titanium (NiTi) wire may be used as the actuator wire **370**. Light gas relief valve **366** opens against the spring loading when a small amount of current is passed through the NiTi wire causing it to shrink or shorten a predetermined amount so that the relief valve is pulled open, thereby allowing lighter-than-air gasses to escape. The actuator rod may pass through the top of the container **302**, preferably through a seal **371**, so that the interior of the container is not directly exposed to the elements. The ballast shuttle gate **322** may similarly be activated with a ballast drop actuator wire **372**, also made of Nickel-Titanium (NiTi). The active antenna stabilizers **316** may similarly be comprised of NiTi wire.

A meteorological drop control wire **374** may also be NiTi and can be used to disconnect the weather sonde after meteorological data is no longer being obtained. Typically, weather balloons burst after they pass approximately 100,000 feet. Here, the balloon will vent some of the light gas to hold at a stratospheric altitude for the desired period of time. The destruct mechanism **78** may be remotely activated with the sharp end **378** of a pivotal destruct arm to cause the platform to fall. The destruct arm **376** is spring-loaded for rapid rotation into contact with the exterior of the balloon when a hold release pin **386** is pulled from engagement in a hold/release groove **384**. The release pin **386** may advantageously be controlled with a control wire **388** also appropriately activated through the circuit board upon receipt of remote signals through the antennae **76** or from the processor. Also provided inside of the platform is a GPS antennae **390** connected to the circuit board for reception of position information from The GPS satellite system to facilitate tracking of the platform as it migrates and floats over the contiguous geographic area of coverage.

FIG. **13** is a schematic side partial cross-section of an alternative embodiment of the platform according to the present invention in which the electrical power source for the communications circuit and controls is a fuel cell **400**. Fuel cell **400** may advantageously be a proton exchange membrane (PEM) fuel cell of the type that uses hydrogen and oxygen to provide electrical power. This type of system requires a hydrogen tube **402** connecting from the source of hydrogen, i.e., the lighter-than-air balloon **70** to the fuel cell **400**. A hydrogen inlet **404** is provided with a hydrogen circulator **406**, which may simply be a fan **406**. Thus, using the hydrogen tube, hydrogen may be extracted from the balloon and inlet into the fuel cell **400**. Also, there is a

hydrogen outlet **408** that is recycled back to the balloon. A hydrogen tube pressure sensor **410** is provided to appropriately monitor the hydrogen partial pressure at the fuel cell. A fuel cell of this type also requires an oxygen supply that may be provided by attaching an oxygen balloon **414** to an oxygen tube **412** so that the oxygen balloon is inside of the hydrogen balloon enclosure. The oxygen balloon is constructed to hold the oxygen at a significant internal pressure. This oxygen balloon **414** may be attached to tube **412** with a rubber band **416** and an oxygen pump **418** moves and further pressurizes oxygen from the oxygen balloon **414** into the fuel cell through an oxygen inlet **420**. Again, to regulate the process an oxygen pressure sensor **422** is provided. The fuel cell reaction results in water as a byproduct. The water is maintained in a liquid state by the heat generated by the fuel cell and is desirably drained before it can freeze at the high altitudes at which the platform operates.

FIG. **14** is a schematic block diagram of the SNS platform hardware contained within the payload box **300** and placed on or interconnected with circuit board **306**. A processor **430** receives electrical signal input and provides electrical signal output, interacting with a plurality of components for both controlling the flotation altitude, temperature, balloon destruction, ballast drop, etc. of the platform and also for receiving, processing and transmitting communication signals received and transmitted to and from ground stations, personal communications devices or other information communications. Initially, block **432** represents either the batteries **308** or the fuel cell **400**. Block **434** represents the on/off switch **328** to activate providing power to a power supply regulation circuit **436** with output available power **438**. For clarity, individual power connections to various operational and control devices have not been shown in all instances. Power is provided to the supply voltage sensor at block **440** and current supply sensor block **442**, which provide information to an analog to digital converter **444**. The analog to digital converter also variously receives information from the payload and battery fuel cell temperature gauge at block **446**, both gas and ambient air temperature readings at block **448** and gas pressure at block **450**. Additional analog informational signals are generally represented by block **452**. Digitally converted information is variously provided to and received from flash memory at block **454** and random access memory (RAM) at block **456**. From A/D converter **444** and also from the flash memory **454** and from RAM memory **456**, the processor has access to all the various input control data. During the ascent of the SNS platform, the meteorological package represented by block **458** receives appropriate weather information including ambient temperature **460**, ambient pressure at **462** and ambient humidity at **464**. The antenna stabilization **316** represented by block **496** may rely upon the attitude sensor information that is part of the SNS platform control system at **466** to stabilize the antenna **76**. Information sensed or gathered by the meteorological package **458** is transmitted. For example, the infrared transceiver **468** through a fiberoptic cable at block **470** corresponding to the physical fiberoptic cable **84** and a processor infrared transceiver **472** by which serial meteorological data is transferred to the processor **430** for appropriate transmission to ground terminals during the ascent of the SNS platform with the meteorological package **458** attached. A GPS antennae block **474**, corresponding to physical GPS antennae **390**, communicates through a GPS receiver **476**, indicated as a serial port and further synchronized with a GPS clock or seconds tick at block **478**. Thus, the position at particular times is provided to the processor. This positioning information is coordinated with the other meteorological input for determining wind speeds steering any part of the ascent, thereby corresponding those wind speeds to particular altitudes and geographical locations during the ascent.

Communications are controlled by processor **430**, preferably using both a 900 MHZ transceiver and modem **480** and a Gateway transceiver and modem **482** signal to and from co-linear array antennae **484** are interfaced through a diplexer **486** control information received at co-linear array antennae **484**, therefore transferred through the diplexer and one of the appropriate frequency transceivers to the processor **430** with input information from ground signals and also from input information from the onboard sensors as provided through A/D converter **444**, the GPS position information from **476**, the GPS time information **478** and the attitude sensor information **466**, various functions of the SNS platform can be controlled. Including the gas vent at block **488** corresponding to the gas vent actuator **370**. Also the ballast drop is controlled at block **490** corresponding to the physical ballast drop actuator **372**. The meteorological package drop controlled schematically at block **492** corresponding to the package drop actuator **374**. The balloon destruct control is depicted at block **494** corresponding to the destruct actuator **376**. Antennae stabilization may be affected according to controls at block **496** corresponding to the antennae stabilization mechanism **316**. Payload temperature controls, both heating and cooling, may be controlled at block **498** corresponding to heaters and coolers **364**. Additional functions as may be additionally included, are provided with controls at block **500**.

Other alterations and modifications of the invention will likewise become apparent to those of ordinary skill in the art upon reading the present disclosure, and it is intended that the scope of the invention disclosed herein be limited only by the broadest interpretation of the appended claims to which the inventors are legally entitled.

What is claimed is:

**1**. A free floating constellation communications system comprising:

a plurality of lighter-than-air platforms comprising at least a first platform and a second platform; said first and second platforms comprising a communications signal transceiver and being free floating without any longitudinal and latitudinal position control; and

a plurality of communications devices within a contiguous geographic area, at least one of said communications devices having communications capability with said communications signal transceivers;

wherein said at least one of said communications devices is capable of handing off communication with said first platform to said second platform as said first platform moves out of a communication range of said at least one of said communications devices, and

wherein said free floating constellation communications system provides a line-of-sight coverage of wireless data to a population on a contiguous landmass and said plurality of lighter-than-air platforms are launched in a manner such that when in an operating range of 60,000 to 140,000 feet there is substantially a relative distance between said plurality of lighter-than-air platforms.

**2**. A free floating constellation communications system (CCS) of claim **1**, further comprising:

an altitude regulator device;

plurality of geographically spaced-apart platform launching sites from which said plurality of platforms can be launched;

a plurality of ground terminals; and

a network of communications links interconnecting at least some of said ground terminals to one another.

**3**. The free floating constellation communications system of claim **2**, wherein said regulator is operatively connected to regulate said platform to float within the stratosphere of the Earth.

**4**. The free floating constellation communications system of claim **2**, wherein a predetermined altitude range within which said plurality of platforms are regulated to float comprises a range of about 70,000 feet to about 100,000 feet.

**5**. The free floating constellation communications system of claim **2**, wherein said regulator regulates the floating of said platform within a predetermined altitude range and comprises a quantity of contained gas having a density less than the density of air within said predetermined altitude range and a controllable vent by which a portion of said quantity of contained gas can be released to reduce the buoyancy of said platform.

**6**. The free floating constellation communications system of claim **2**, wherein said regulator comprises a quantity of high density material carried onboard said platform and a release device by which a portion of said high density matter can be released to increase buoyancy of said platform.

**7**. The floating constellation communications system of claim **2**, wherein said regulator comprises:

a controllable gas vent;

a controllable ballast release device;

an altitude determining mechanism; and

a control signal processor device connected with said transceiver, said altitude determining mechanism, said gas vent and ballast release so that the altitude can be adjusted.

**8**. The free floating constellation communications system of claim **2**, wherein said communications system of said plurality of spaced-apart ground terminals comprise a transceiver.

**9**. The free floating constellation communications system of claim **8**, wherein at least one of said spaced-apart ground terminals comprises a network operation center.

**10**. The free floating constellation communications system of claim **9**, wherein the network operation center comprises circuitry for controlling a predetermined operation of the platform.

**11**. The free floating constellation communications system of claim **2**, further comprising a network operation center (NOC) connected to said network of communications links.

**12**. The free floating constellation communications system of claim **11**, wherein said NOC is connected to at least some of said plurality of ground terminals with a hub and spoke arrangement of communications links.

**13**. The free floating constellation communications system of claim **11**, wherein said NOC is connected to at least some of said plurality of ground terminals with a mesh arrangement of communications links.

**14**. The free floating constellation communications system of claim **2**, wherein said network of communications links interconnecting said ground terminals comprises connections to ground lines.

**15**. The free floating constellation communications system of claim **2**, wherein said network of communications links interconnecting said ground terminals comprises space satellite communications links.

**16**. The free floating constellation communications system of claim **2**, wherein said network of communications links comprises platform-to-platform communications links.



**17**. The free floating constellation communications system of claim **1**, further comprising a tracking device, wherein said tracking device comprises:

a directional antenna; and

a directional antenna aiming mechanism responsive to GPS coordinate data for selectively aiming said directional antenna at one or more of said plurality of platforms.

**18**. The free floating constellation communications system of claim **17**, wherein said tracking device comprises:

a directional antenna; and

a directional antenna aiming and gain tracking mechanism for aiming said directional antenna at a selected platform according to a communications signal strength between said selected platform and said directional antenna.

**19**. The free floating constellation communications system of claim **1**, wherein said plurality of platforms comprise a lighter-than-air device selected from the group consisting of a balloon, a blimp, an aerostat, a zeppelin, an airship, a dirigible, a weather balloon, ajimsphere, a hot air balloon, a sounding balloon and a meteorological balloon and combinations thereof.

**20**. The free floating constellation communications system of claim **1**, wherein said plurality of platforms comprise rubber balloons.

**21**. A free floating constellation communications system as in claim **1** wherein said platforms comprise zero-pressure balloons.

**22**. A free floating constellation communications system as in claim **1** wherein said platforms comprise internal air bladder balloons.

**23**. A free floating constellation communications system as in claim **1** wherein said platforms comprise adjustable volume balloons.

**24**. The free floating constellation communications system of claim **1**, wherein said platforms comprise hdrogen-filled balloons.

**25**. A free floating CCS as in claim **1** wherein said communications devices comprise pagers.

**26**. A free floating CCS as in claim **1** wherein said communications devices comprise advanced messaging devices.

**27**. A free floating CCS as in claim **1** wherein said communications devices comprise wireless telephones.

**28**. A free floating CSS as in claim **1** wherein said communications devices comprises telemetry devices.

**29**. A free floating CSS as in claim **1** wherein said communications devices comprises equipment tracking units.

**30**. A free floating CSS as in claim **1** wherein said communications devices comprises personal tracking units.

**31**. A free floating CCS as in claim **1** wherein:

a) said platform comprises a rapid descent mechanism; and

b) said platform is disposable.

**32**. A free floating CCS as in claim **1** wherein:

a) said platform comprises a balloon;

b) said platform comprises a rapid descent mechanism; and

c) said balloon is replaceable for recovery and reuse of said transceiver.

**33**. The free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using Frequency Division Multiple Access (FDMA) protocol.

**34**. Free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using Time Division Multiple Access (TDMA) protocol.

**35**. The free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using Code Division Multiple Access (CDMA) protocol.

**36**. The free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using the ReFLEX protocol.

**37**. The free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using the Flex protocol.

**38**. The free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using the POCSAG paging protocol.

**39**. The free floating CCS of claim **1**, wherein said communications signal transceiver comprises circuitry capable of communications using the ERMES paging protocol.

**40**. The free floating constellation communications system of claim **1**, further comprising:

an altitude determining mechanism;

a source of meteorological data; and

controls for adjusting the altitude of a platform into a wind velocity and direction determined according to said meteorological data.

**41**. The free floating constellation communications system of claim **1**, further comprising:

an attitude sensor onboard at least one said plurality of platforms; and

a steerable antenna coupled to at least one of said communications signal transceivers and attached to at least one of said plurality of platforms, said steerable antenna having stabilization controls for stabilizing said steerable antenna in a direction from said platform provides consistent ground coverage over said geographic area.

**42**. The free floating constellation communications system of claim **41**, further comprising an aim control operatively associated with said steerable antenna and said altitude sensor for selectively changing the position of the coverage area of said antenna to facilitate filling gaps of coverage over said geographic area.

**43**. Free floating constellation communications system of claim **1**, wherein at least one of said platforms comprise:

an unmanned free balloon; and

a payload box having a total weight less than six pounds and exterior surfaces with predetermined areas and that has a weight to size ratio of no more than three ounces per square inch on any surface of the package, determined by dividing the total weight in ounces of the payload box by the area in square inches of its smallest exterior surface.

**44**. The free floating constellation communications system of claim **1**, wherein at least one of said plurality of platforms further comprises an altitude regulator operatively connected to regulate the platform to float within a predetermined altitude range after initial ascent;

wherein said altitude regulator further comprises:

a quantity of high density material; a device for determining the altitude of said platform, wherein said device for determining the altitude of said platform comprises a global positioning system (GPS) receiver; and a material release mechanism for releasing a portion of said quantity of high density material.

**45**. The free floating constellation communications system of claim **1**, further comprising:

a hydrogen gas enclosure for holding a quantity of hydrogen;

an onboard electrical power source on at least one of said platforms, wherein said on-board electrical power source comprises a fuel cell interconnected with said hydrogen gas enclosure for receiving hydrogen as a component of the fuel for said fuel cell; and

an altitude regulator attached to said platform to regulate the altitude of said platform within a predetermined altitude range, said altitude regulator comprising:

an altitude determining mechanism;

a controllable vent from said gas enclosure and vent controls operatively coupled with said altitude determining mechanism for venting of said hydrogen gas for regulating the altitude of said platform; and

a controllable ballast release attached to said platform to release ballast for regulating the altitude of said platform.

**46**. The free floating constellation communications system of claim **45**, wherein said controllable vent and vent controls operatively coupled thereto further comprise at least one Nickel-Titanium (NiTi) element mechanically coupled to said control vent and operatively connected to said electrical power source for selectively receiving and not receiving electrical power to thereby selectively change the length of said NiTi element for opening and closing said controllable vent.

**47**. The free floating constellation communications system of claim **45**, further comprising a meteorological package connected to said platform through a fiber optic link to said transceiver thereby substantially preventing electrical arcing between said meteorological package and said transceiver when said platform moves through electrically charged clouds.

**48**. The free floating constellation communications system of claim **1**, further comprising a tracking system capable of tracking one or more of said plurality of platforms.

**49**. The free floating constellation communications system of claim **1**, further comprising a rapid deflation system for removing a platform from the air upon malfunction or improper location of the platform.

**50**. A free floating constellation communications system comprising:

a plurality of lighter-than-air platforms comprising at least a first platform and a second platform, each of said first and second platforms comprising a communications signal transceiver and being free floating without any longitudinal and latitudinal position control; and

a plurality of communications devices within a contiguous geographic area, at least one of said communications devices having communications capability with said communications signal transceivers;

wherein said at least one of said communications devices is capable of receiving communications from said communications signal transceiver of said first platform and said communications signal tranceiver of said second platform, but hearing communications from only one communications signal transceiver and said plurality of lighter-than-air platforms are launched in a manner such that when in an operating range of 60,000 to 140,000 feet there is substantially a relative distance between said plurality of lighter-air-platforms.

**51**. A free floating constellation communications system comprising:

a plurality of lighter-than-air platforms comprising at least a first platform and a second platform, each of said first and second platforms comprising a communications signal transceiver and being free floating without any longitudinal and latitudinal position control; and

a plurality of communications devices within a contiguous geographic area, at least one of said communications devices having communications capability with said communications signal transceivers;

wherein said first and second platforms dynamically assign new frames in which to transmit communication signal from said communications signal transceiver as the platforms drift such that a comunications device receives communications signals from only one communications signal transceiver in a particular frame and said plurality of lighter-than-air platforms are launched in a manner such that when in an operating range of 60,000 to 140,000 feet there is substantially a relative distance between said plurality of lighter-than-air platforms.

**52**. A method of communicating using a free floating constellation communication system comprising:

providing a communication device for communicating wit lighter-than-air platforms;

communicating with a first lighter-than-air platform when the communication device is in a communication range of the first-lighter-than-air platform,

communicating with a second lighter-than-air platform when the communication device moves out of the communication range of the first lighter-than-air platform, wherein the first and second lighter-than-air platforms each comprise an altitude regulator device and a communications signal transceiver and wherein the first and second lighter-than-air platforms are free floating without any longitudinal and latitudinal position control and said plurality of lighter-than-air platforms are launched in a manner such that when in an operating range of 60,000 to 140,000 feet there is substantially a relative distance between said plurality of lighter-than-air platforms.

**53**. The method of claim **52**, wherein the communication device comprises a pager.

**54**. The method of claim **52**, wherein the communication device comprises a an advanced messaging device.

**55**. The method of claim **52**, wherein the communication device comprises a wireless telephone.

**56**. The method of claim **52**, wherein said altitude regulator device regulates the altitude of said platform to within a predetermined altitude range of between about 60,000 feet and about 140,000 feet.

**57**. The method of claim **52**, wherein said altitude regulator device is operatively connected to regulate the platform to float within the stratosphere of the Earth.

**58**. The method of claim **52**, wherein said altitude regulator regulates the floating of said platform within a predetermined altitude range and comprises a quantity of contained gas having a density less than the density of air within said predetermined altitude range and a controllable vent by which a portion of said quantity of contained gas can be released to reduce the buoyancy of said platform.

**59**. The method of claim **52**, where in said altitude regulator comprises a quantity of high density material carried onboard said platform and a release device by which a portion of said high density matter can be released to increase buoyancy of said platform.

**60**. A method of communicating using a free floating constellation communications system comprising:

providing a plurality of lighter-than-air platforms comprising at least a first platform and a second platform, each of said first and second platforms comprising a communications signal transceiver and being free floating without any longitudinal and latitudinal position control; and

communicating with a communication device having communications capability with said communications signal transceiver, wherein said first and second platforms dynamically assign new frames in which to transmit communication signals from said communications signal transceivers as the platforms drift such that a communication device receives communications signals from only one communications signal transceiver in a particular frame and said plurality of lighter-than-air platforms are launched in a manner such that when in an operating range of 60,000 to 140,000 feet there is substantially a relative distance between said plurality of lighter-than-air platform.

**61**. The method of claim **60**, wherein the communication device comprises a pager.

**62**. The method of claim **60**, wherein the communication device comprises a an advanced messaging device.

**63**. The method of claim **60**, wherein the communication device comprises a wireless telephone.

**64**. The method of claim **60**, wherein said altitude regulator device is operatively connected to regulate the platform to float within the stratosphere of the Earth.

**65**. The method of claim **60**, wherein said altitude regulator regulates the floating of said platform within a predetermined altitude range and comprises a quantity of contained gas having a density less than the density of air within said predetermined altitude range and a controllable vent by which a portion of said quantity of contained gas can be released to reduce the buoyancy of said platform.

**66**. The method of claim **60**, wherein said altitude regulator comprises a quantity of high density material carried onboard said platform and a release device by which a portion of said high density matter can be released to increase buoyancy of said platform.

**67**. A method for providing communication service comprising:

providing a first lighter-than-air platform;

providing a second lighter-than-air platform wherein the first and second lighter-than-air platforms each comprise an altitude regulator device and a communications signal transceiver and wherein the first and second sight-than-air platforms are free floating without any longitudinal and latitudinal position control;

providing a plurality of communications devices within a contiguous geographic area, at least one of said communications devices having communications capability with said communications signal transceiver, wherein said at least one of said communications devices is capable of handing off communication with said the platform to said second platform as said first platform moves out of a communication range of said at least one of said communications devices and wherein said free floating constellation communications system provides a line-of-sight wireless data coverage to a population on a contiguous landmass and said plurality of lighter-than-air platforms are launched in a manner such that when in an operating range of 60,000 to 140,000 feet there is substantially a relative distance between said plurality of lighter-than-air platforms.

**68**. The method of claim **67**, wherein the communication device comprises a pager.

**69**. The method of claim **67**, wherein the communication device comprises a an advanced messaging device.

**70**. The method of claim **67**, wherein the communication device comprises a wireless telephone.

**71**. The method of claim **67**, wherein said altitude regulator device is operatively connected to regulate the platform to float within the stratosphere of the Earth.

**72**. The method of claim **67**, wherein said altitude regulator regulates the floating of said platform within a predetermined altitude range and comprises a quantity of contained gas having a density less than the density of air within said predetermined altitude range and a controllable vent by which a portion of said quantity of contained gas can be released to reduce the buoyancy of said platform.

**73**. The method of claim **67**, wherein said altitude regulator comprises a quantity of high density material carried onboard said platform and a release device by which a portion of said high density matter can be released to increase buoyancy of said platform.

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# EXHIBIT C
# REDACTED

# ENTIRE EXHIBIT
# SUBMITTED UNDER SEAL

# EXHIBIT D
# REDACTED

# ENTIRE EXHIBIT
# SUBMITTED UNDER SEAL